POWER

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The Artisan and the Drudge

IT IS common to deplore the waning of the old arts and crafts spirit in industry, the passing of the master who worked with his men and imbued them with his personal pride in their product.

It is fashionable to bewail the monotonous existence of the "hands" who pass their lives performing the same mechanical operation hour after hour and day after day.

Yet in order that men may be fed and clothed and sheltered and may enjoy some of the comforts and conveniences and the cultural and agreeable things of life, there must be a lot of tedious, repetitive drudging work done.

And in spite of all that is said about the mechanical grind and industrial slavery, the average day's work is shorter and easier and yields to the workman a greater return than ever before in the history of the race.

Much of the arduous physical labor for which the world was formerly dependent upon the muscular exertion of millions of human toilers, is now performed by tireless and insentiate machinery. The operator's task has become that of guiding its operations. Monotonous this may be, offering little mental stimulus or spiritual inspiration.

But is the condition of the average manual workman less favorable to mental and intellectual development than it was when he had to work as long as the light lasted upon physically exhausting tasks?

Has he not easy access, even upon the farms and in rural communities, to the recorded and the current products of the world's best thought and talent?

Is he not better equipped mentally to absorb and appreciate and enjoy and profit by them?

And has he not a lot more time for such recreation and study and thinking, better mental tools and cultural equipment than he ever had before?

Are there not greater opportunities than ever for those who can rise above mediocrity to get up out of the rank and file, even in their own occupations?

What, then, is all this talk about the deadening effects of the factory system; the soiling of the fabric of life by the grime of industrialism? Is the growth of the spirit stunted because the flesh is made more comfortable?

F. R. Low

Double-Acting Engines of the Motorship "Gripsholm"

Largest Diesels Seen on This Side of the Atlantic—Units 8,300 Horsepower Each

WHILE Diesel engines of five thousand horsepower and over have been built by several European manufacturers, the 8,300-hp. units on the motorship "Gripsholm" are the first of these larger oil engines that have ever been seen on this side of the Atlantic Ocean.

The "Gripsholm" is one of the Swedish-American motorships constructed since the war. The vessel, which is 575 ft. long by 76 ft. beam, has accommodations for 1,600 passengers and for a crew of 327, and has a gross tonnage of 17,000 tons. The "Gripsholm" was built at the yards of Sir W. G. Armstrong & Co., Newcastle-on-Tyne, England, but the engines were built by Burmeister & Wain, of Copenhagen, Denmark.

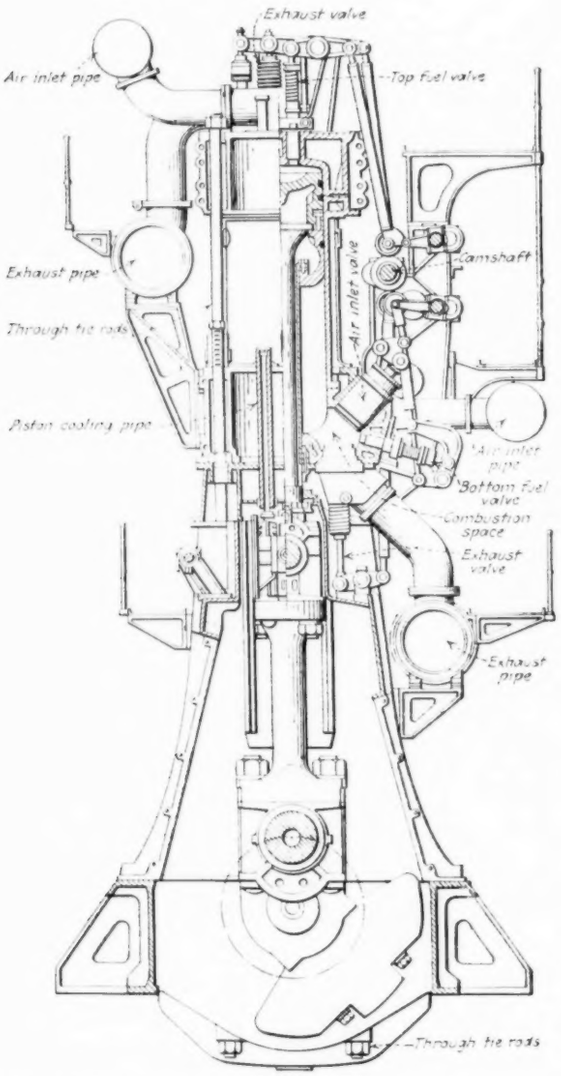


Fig. 1—Cross-section of "Gripsholm's" double-acting four-stroke-cycle Diesels

The two main engines drive the two propellers directly through extended shafts and rigid couplings. Each unit is made up of six cylinders 33⅛ in. diameter by 59⅛-in. stroke and at the rated speed of 125 r.p.m. develops a shaft output of 6,750 hp.

A piston speed of approximately 1,250 ft. excites comment, inasmuch as it is considerably higher than is customary. In view of the heavy reciprocating parts the crank throws are provided with counterweights. As an additional preventive of vibration cross-bracings were installed between the upper parts of the two engines.

The cylinders are double-acting and, as will be seen from Fig. 1, the combustion space for the lower cylinder end is in the form of a cavity at one side of the cylinder. In this chamber are the air-admission, exexhaust and fuel valves.

Cylinder Construction

The cylinder is made up of a simple cast-iron liner surrounded by a cast-iron water-jacket cover. The lower cylinder head rests on the frame box and supports the liner and upper cylinder head, the assembly being tied together by tension rods some 32 ft. long. The camshaft is placed along the cylinders, being driven by a roller chain from the crankshaft. The upper valves are actuated by long reach rods, while the lower valve rods are somewhat shorter. The piston, as will be seen from Fig. 1, is short and the rod is provided with a cast-iron thimble which serves to keep the direct flames away from the steel rod. The crosshead is of a conventional design, as is also the connecting rod, although the latter, Fig. 4, is of interest in that it is 13½ in. in diameter.

The air for injection and starting is supplied by three 4-cylinder 600-hp. Diesels direct connected to twin compressor units. Auxiliary power for the deck machinery, lighting, etc., is supplied by three 600-hp. units driving direct-current generators, which also supply electricity for all cooking.

The cooling of the engine is done by water circulating in a closed system and recooled by sea water. The water pumps and other auxiliary equipment are shown in Fig. 5. According to estimates, while running at 17 knots the main and auxiliary engines will consume 70 tons of oil a day at a cost of $1,076, compared with the 190 tons consumption of an equivalent main and auxiliary steam-turbine installation at a cost of $1,799, making a difference of over $5,500 for a single voyage between Gothenberg and New York. The total saving that will be effected in a year, allowing for the time in port, etc., is estimated at more than $150,000 for this one ship alone.

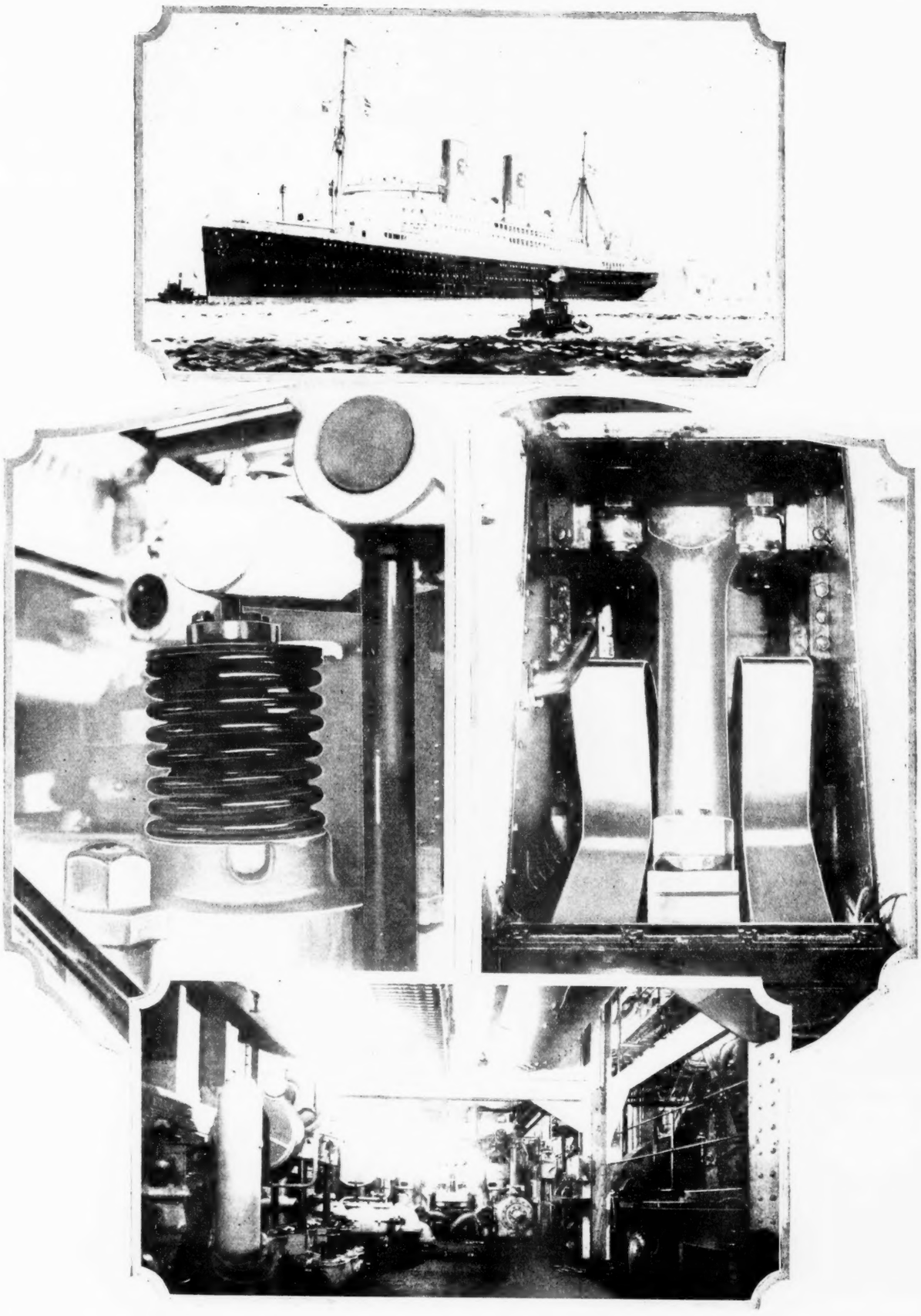


Fig. 2 (top)—The 17,000-ton motorship "Gripsholm." Fig. 3 (center left)—Valves having double springs. Fig. 4 (center right)—Connecting rod and crank throws. Fig. 5 (bottom)—Auxiliary engines and pumps

Test of Boilers in the Central Station of the Mines of Courrières, France*

IT IS somewhat startling and certainly interesting to find a 50,000-kw. generating station serving a group of coal mines. This is a substantial plant, up-to-date in every particular, as indicated by the accompanying photographs. In considering the efficiencies recorded for the boiler test, it should be borne in mind that these are based on the lower heat values of the fuel. While exact correction is impossible in the absence of more precise information, it is probable that a correction of these figures to the usual American basis of the higher heat value, would lower the boiler efficiency by something of the order of four or five points in the efficiency scale.

WHEN after the war the Compagnie des Mines de Courrières reorganized its devastated undertakings, it built a central power station to furnish electric current to its numerous mines. The plant contains sixteen boilers of 5,900 sq.ft. of heating surface each, and five turbine alternator units of 10,000 kw. capacity each, with two rotary converters, high- and low-tension switchboards, etc.

Recent tests at different rates of steaming show that the boilers have exceeded their guarantee. A number

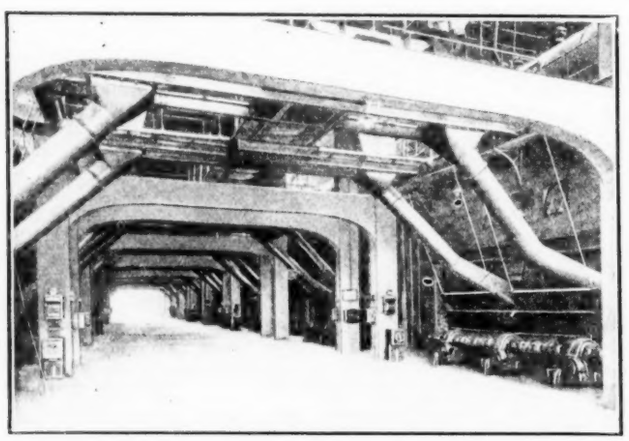


Fig. 1—The boiler-room firing aisle is well arranged and shows what can be done with reinforced-concrete construction

of observations of temperature, draft, flue-gas composition, etc., were made during the test and the accompanying table and curves show these results.

The sixteen boilers are of the water-tube type with two drums and curved tubes, which gives a boiler of great flexibility, responding quickly to sudden changes of load. As is evident in Fig. 3, each boiler has a superheater of serpentine tube design at the rear of the boiler, and two cast-iron tube economizers placed immediately above the superheater. The flue gas passes from the economizers into two air heaters placed behind the economizers to facilitate the combustion of the

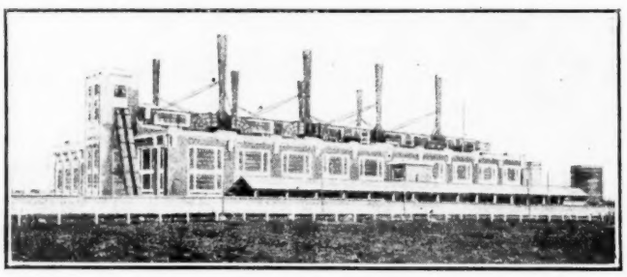


Fig. 2—The substantial plant building is characteristic of European coal-mining practice, which is organized for long-time operation

high-ash coal, whose use is interesting in the power station of a mining company. Each group of two boilers has a single stack with an induced-draft fan, and each boiler is served by an Erith-Riley stoker with eleven retorts. Copes feed-water regulators are used, and all the accessory material has been selected with considerable care.

General Characteristics

The general characteristics of each boiler are as follows: Pressure, 260 lb. per sq.in.; heating surface of the boiler, 5,900 sq.ft.; superheater surface, 3,250 sq.ft. Economizer surface, 4,000 sq.ft. Air-heater surface, 4,300 sq.ft.; normal rating of the boiler, 5.73 lb. of steam per square foot per hour; possible continuous rating, 6.93 lb. per sq.ft. per hour; expected over-all efficiency, 75.5 per cent; lower calorific value of the fuel contemplated, 10,800 B.t.u. per lb.

The feed piping, the motor-driven forced-draft fans and the motor driving the stokers are in a special chamber below the boiler-operating floor, so as to protect this apparatus against coal dust and ashes. Fig. 4 shows the central aisle of this lower level.

The coal falls directly from storage bins into a traveling larry of about 1,100 lb. capacity, which delivers it to large hoppers from which it is fed to the stoker hoppers.

Ashes are handled in the basement, where they fall into two sluices (one is a reserve) filled with water and fitted with drag-chain conveyors.

Testing the Boilers

The tests were made on a boiler chosen at random and run at different ratings. The water meter used to measure the feed water as an indication of the steam generated, was calibrated with care before the test. The usual precautions were taken to avoid the loss of water through the blowoff, drain and safety valves.

*Abstracted from the October, 1925, issue of the *Bulletin de la Société Alsacienne de Constructions Mécaniques*.

The temperature of water entering and leaving the economizers and of the steam at the exit from the superheater was measured by mercury thermometers. The temperature of the flue gas was read by resistance

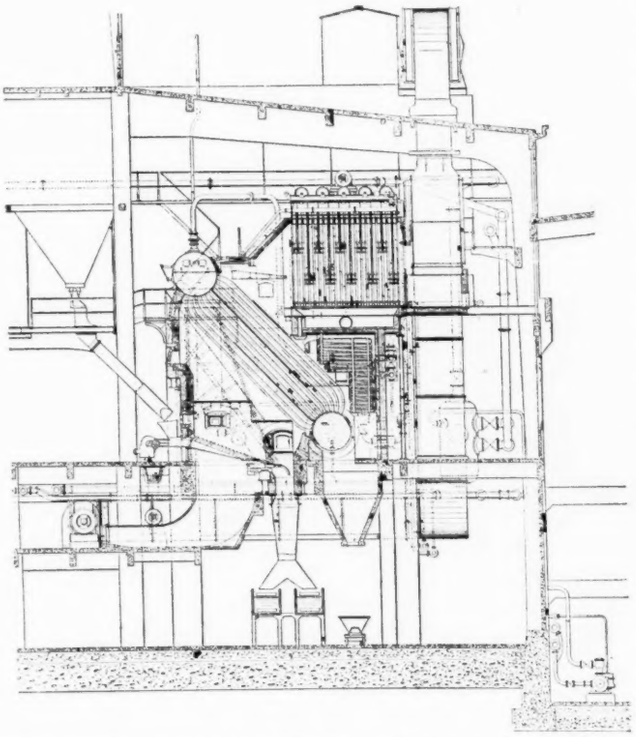


Fig. 3—Sixteen identical boilers show care in the design of a compact setting for boiler, superheater, economizer and air heater. Coal and ash handling are well cared for

thermometers at various points in the gas path. The composition of the flue gas was determined by means of Orsat apparatus.

The boiler was in normal operating condition and was maintained as nearly as possible free from dust

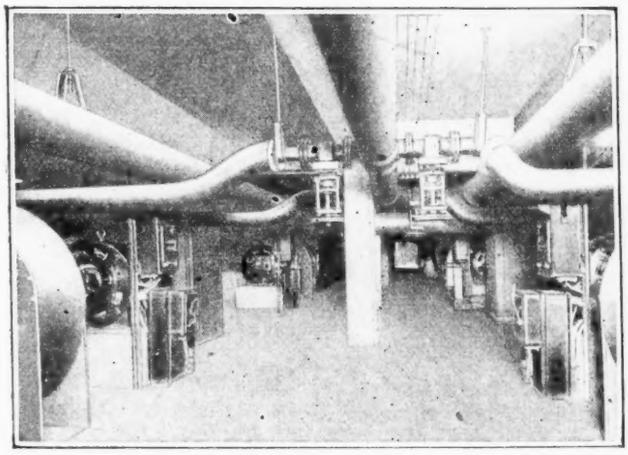


Fig. 4—The principal piping, fans and motors are on the floor below the firing floor

by the aid of Diamond soot blowers. Prior to each test run the boiler was in steady operation for several hours.

The coal burned was composed of screenings from the mine having a lower calorific value for the untreated moist coal of about 10,700 B.t.u. per pound.

Each test run was prolonged, to reduce the errors due to variations in the state of the fire at the beginning and end of the test.

The determination of loss due to unburned combustible in the refuse was made by analysis of an average sample.

Making the Tests

Four tests were made at ratings of 3.42, 6.02, 7.02, and 7.78 lb. of steam per hour per square foot of heating surface. In addition, without making complete tests, temperatures, drafts and flue-gas analyses were taken at a rating of 4.61 lb. per sq.ft. per hour, and these indications have been used along with the others in establishing the curves. All the interesting results are assembled in Table I, with the columns arranged in the order of increasing rating.

The efficiency obtained is regarded as high, and is attributed to a wise choice of apparatus, resulting in a

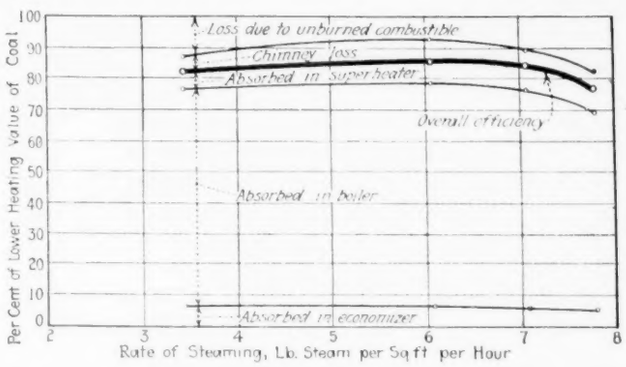


Fig. 5—Heat-balance results are based on the lower heating value of the fuel, which is about 5 per cent less than the higher value generally used in America

low temperature of gas leaving the air heater, and in consequence a very small chimney loss, as the table shows.

The loss by radiation becomes of less importance as the rate of steaming rises. On the contrary, the loss by unburned gas increases with the rate of steaming, and this is one of the causes of the drop in efficiency indicated when the rate of steaming reaches 7.78 lb. of steam per square foot per hour, in test No. 5.

On the other hand, the weight of coal burned during this test is particularly small, owing to its short duration, and the relative errors of starting and stopping may be great. It is probable that the weight of coal left on the stoker is excessive, and this makes an apparent efficiency too small and the loss by unburned combustibles too high. The exact efficiency is probably much better, as indicated by all the temperatures and notably those of the flue gas leaving the chimney.

[Short test runs with underfeed stokers are subject to serious errors due to variation in the quantity of coal in the fire bed at the start and finish of the run.—Editor.]

The coefficient of heat transfer in the superheater and economizer has been calculated by means of the relevant figures. The results are shown in Table II. The value of these coefficients increases with the rating

of the boiler, which is accompanied by a simultaneous increase of gas temperature and velocity.

The curves in Fig. 5 have been drawn with the results of the heat balance computations plotted against the rate of steaming. It seems that with a variable load between 50 and 130 per cent of the normal rate of

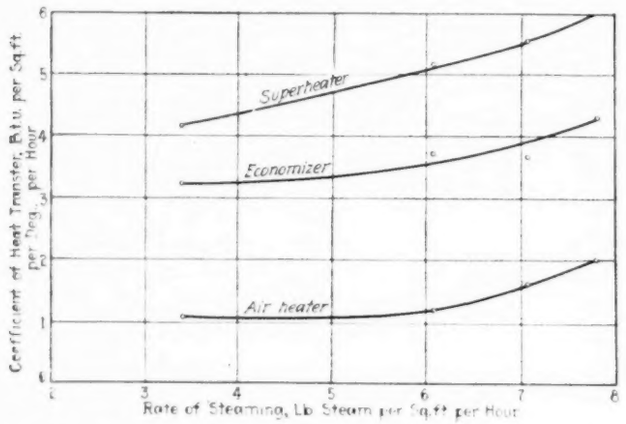

Coefficient of Heat Transfer, B.t.u. per Sq.ft. per Deg. F. per Hour
Superheater
Economizer
Air heater
Rate of Steaming, Lb. Steam per Sq.ft. per Hour

Fig. 6—The coefficients of heat transfer as calculated from the test results

steaming, the efficiency remains good. This type of boiler will respond to widely varying demands with flexibility and regularity.

Fig. 6 shows the variation with rating of the heat transfer coefficients in air heater, economizer and superheater.

TABLE I—RESULTS OF THE TESTS

The data have been arranged, so far as possible, in accordance with the A.S.M.E. Test Code for Stationary Steam Boilers. The item numbers refer to that code. Added items carry no number.

Run No.	1	2	3	4	5
(1) Date, June, 1925	10–11	11–12	5	8–9	9
Fuel Proximate Analysis—Dry					
(22) Volatile matter	18.9	....	19.6	19.4	19.3
(23) Fixed carbon	60.9	....	58.2	59.1	61.5
(24) Ash	20.2	....	22.2	21.5	19.2
Fuel Ultimate Analysis—as received					
(25) Moisture	1.6	....	2.6	1.6	2.1
(30) Carbon	70.0	....	67.0	68.3	70.6
(31) Hydrogen	3.5	....	3.5	3.5	3.5
(32) Oxygen	5.0	....	5.3	5.5	5.0
(35) Ash	19.9	....	21.6	21.1	18.8
(26) Heating value, B.t.u. per lb. as fired (Lower heating value)	11,350	....	10,950	11,260	11,280
Gas					
Per cent CO_2 entering superheater	9.3	10.0	10.6	11.3	12.3
Per cent CO_2 superheater outlet	8.6	9.1	9.7	10.7	11.4
(37) Per cent CO_2 boiler outlet	8.1	8.7	9.0	10.0	10.4
(38) Per cent CO_2 economizer outlet	7	8.1	8.4	9.6	9.8
(39) Per cent CO_2 air heater outlet	7.5	7.7	8.0	9.1	9.3
Pressures and Drafts					
(47) Steam pressure, * lb. per sq.in.	242	245	250	252	245
(49) Air pressure in windbox, in. of water	0.70	0.75	2.44	2.68	3.64
(50) Draft in furnace, † in. of water	0.016	0.039	−0.067	−0.071	−0.118
(51) Draft at boiler outlet, in. of water	0.24	0.24	0.22	0.23	0.24
(52) Draft at economizer outlet, in. of water	0.30	0.31	0.37	0.39	0.40
(53) Draft at air heater outlet, in. of water	0.41	0.49	0.59	0.91	1.14
Temperatures					
(54) Steam temperature, Deg. F.	536	547	572	587	605
(58) Air entering air heater	122	122	120	120	124
(60) Air entering stoker	167	167	172	171	183
Gas entering superheater	669	718	829	896	923
Gas leaving superheater	511	504	565	594	623
(62) Gas leaving boiler	387	392	468	502	511

TABLE I—CONCLUDED

(63) Gas leaving economizer	304	304	363	352	381
(64) Gas leaving air heater	237	235	282	259	268
(65) Feed water entering boiler	248	237	246	237	253
(66) Feed water entering economizer	158	158	158	155	164
Hourly Quantities					
(69) Duration of test, hours	33	24	16.5	19	8
(70) Fuel as fired per hour, lb.	2,506	....	4,480	5,250	6,350
(73) Fuel as fired, per retort per hour, lb.	227	....	408	474	580
(78) Actual water per hour, lb.	20,290	27,300	35,720	41,680	46,090
Refuse					
(83) Combustible in refuse, per cent	27.2	....	....	24	26
Loss of carbon, per cent of coal as received	7.43	....	....	6.7	6.6
Evaporation					
(85) Actual evap. per lb. fuel as fired, lb.	8.05	....	7.97	8.00	7.26
Actual evap. per sq.ft. heating surface per hour, lb.	3.42	4.61	6.02	7.02	7.78
Efficiency					
(92) Efficiency ‡ of stoker, furnace, boiler, superheater, economizer, and air heater, per cent	81.8	....	85.4	84.2	76.4
Heat Balance					
Heat Values					
Heat per lb. coal as fired (lower heating value) per cent	100	....	100	100	100
Heat absorbed by by water and steam in boiler, per cent	70.0	....	72.0	71.0	63.2
(4096) Heat absorbed by steam in superheater, per cent	5.5	....	7.6	7.4	7.5
(4097) Heat absorbed by water in economizer, per cent	6.3	....	6.4	5.8	5.7
Losses					
Flue gas, per cent	5.2	....	6.8	5.2	5.6
(4098) Unburned solids, per cent	9.6	....	7.8	8.8	8.6
Radiation and unaccounted for per cent	3.4	....		1.8	9.4

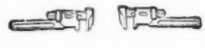
* It is not stated whether this is gage or absolute pressure, or whether it is taken at boiler or superheated outlet.

† Negative draft means pressure above atmosphere.

‡ Based on the lower heating value of the fuel. The figures based on the higher value would probably be about 78, 81, 86, and 73. Exact correction can be made only when it is known how the lower heating value was calculated.

TABLE II—COEFFICIENTS OF HEAT TRANSFER, B.T.U. PER SQ.FT. PER DEG. F. PER HOUR

Rate of steaming, lb. steam per sq.ft. per hour	3.42	6.02	7.02	7.78
Coefficient for superheater	4.16	5.12	5.53	6.04
Coefficient for economizer	3.21	3.71	3.65	4.30
Coefficient for air heater	1.10	1.31	1.59	2.00



Percentages are a constant source of confusion. When a certain percentage is said to increase or decrease so many per cent, the reader is frequently at a loss to know what is meant. If any plant with 60 per cent boiler efficiency reports a 10 per cent increase, some will take the new efficiency to be 70 per cent, while others will figure it $60 + (0.1 \times 60) = 66$ per cent. While the second is probably the more logical interpretation, it is not universally recognized by engineers. It would be a great advance if per cent change were always understood as *a percentage of the original value*, leaving the term "points" to designate the numerical difference between two percentages. On this basis an increase from 60 per cent to 66 per cent could be referred to as an increase of 10 per cent, or as an increase of 6 points. The term "points" has the advantage of being well understood in the commercial world.

Operation of Counter-E.M.F.-Type Voltage Regulator

Regulator Operation Described—Proper Protection of Generators—Putting the Regulator in and out of Service—Parallel Operation of Generators—Main Control and Relay Magnet Adjustments—Operation of Regulating Motor

By F. A. BYLES
Flow-Meter and Regulator Engineering Department, General Electric Company

OF THE large number of counter-e.m.f.-type voltage-regulator installations recently made in this country on direct-current generators, few are more interesting than the one at the National Biscuit Co.'s plant at Marseilles, Ill. This regulator, Fig. 1, is of the latest design, for broad-range, flickerless, high-field current operation and embodies many interesting features.

Fig. 2 shows the elementary circuit for a regulator of this type. The voltage of a direct-current generator

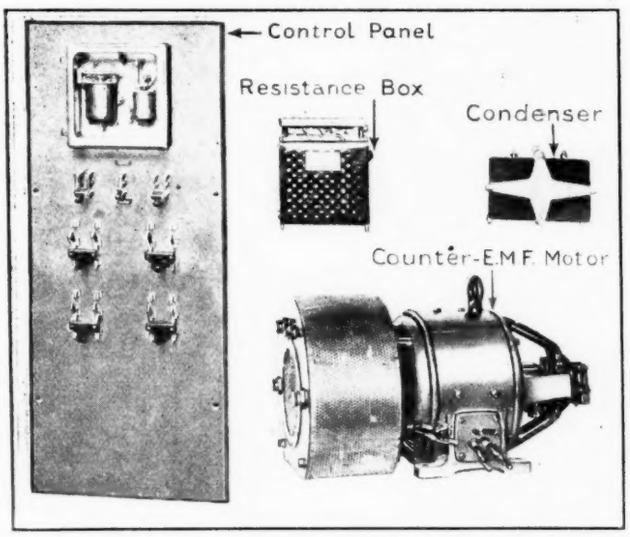


Fig. 1—Parts of counter-e.m.f. voltage regulator

may be changed either by cutting in or out resistance in series with the shunt-field circuit or by setting up a variable counter-e.m.f. in the same circuit. The latter principle is made use of in this regulator, a means being provided for varying the counter-e.m.f. automatically in order to bring about the regulation desired.

A direct-current motor when in operation produces a counter-e.m.f. in its armature circuit and is the basic principle of this regulator. By controlling the shunt field of the motor by means of a set of contacts actuated by a control solenoid, the counter-e.m.f. is automatically varied as required to keep the generator field strength at the proper value for the desired regulation. The armature of the counter-e.m.f. motor is kept from overspeeding by a brake attached to the motor shaft. In the case of small regulators an air fan is sufficient, but in the larger sizes either an eddy current or generator brake is used.

In Fig. 2 the counter-e.m.f. motor's armature is connected in series with the field rheostat and generator's shunt field and across the generator's armature, from *A* to *B*. From terminal *E* of the shunt-field winding, part of the current passing through the counter-e.m.f. motor's armature is shunted through the anti-hunting winding on the main control magnet to *F*. The field of the motor is connected across the generator terminals from *C* to *D*. On the main control magnet the potential winding is connected across the generator from *G* to *H*. When the voltage exceeds a given value, the current through the potential coil on the main control magnet will open the contacts and cut the counter-e.m.f. motor's field into circuit. This increases the excitation in the motor's field poles and increases the counter-voltage in the generator's field circuit, which in turn reduces the generator's field current and voltage.

When the generator's voltage decreases below a given value, the contacts on the main control magnet close and short-circuit the counter-e.m.f. field, which causes the counter-e.m.f. of the regulating motor to be reduced. This allows the generator's field current to increase and raise the voltage. The contacts on the main control magnet open and close on small change in potential, therefore the voltage is held within close ranges, as will be subsequently explained.

The regulator installed at the Marseilles plant has a maximum field-current capacity of 100 amperes and regulates the voltage of any combination of four 125-volt direct-current generators.

Fig. 3 shows the counter-e.m.f. motor with the guard removed over the eddy-current brake mechanism. With reference to the diagram of connections for this regulator, Fig. 4, it should be noted that the complete connections for the generators and switchboard apparatus have not been shown, but only those necessary to make clear the operation of the regulator.

Method and Cycle of Operation

The connections for the regulator described differ from the elementary connections shown in Fig. 2, as a relay is used in addition to the main control magnet in order satisfactorily to handle a counter-e.m.f. motor field current, which is larger than can be conveniently carried by the main control contacts direct. It will also be noted that the relay contacts open and close the counter-e.m.f. motor field circuit when they operate instead of short-circuiting it as shown by Fig. 2.

Either method may be used to advantage, but the method shown in Fig. 4 is frequently preferred when a regulator is to be used with large slow-speed generators, as in the case of the installation referred to previously.

Each generator has its field circuit connected to a double-pole, double-throw (heel-and-toe style) switch

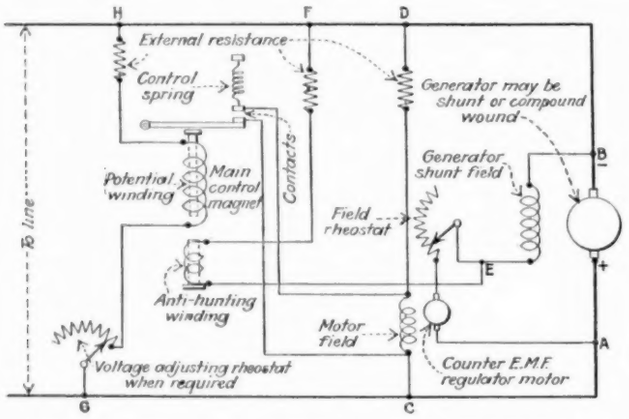


Fig. 2—Elementary diagram for counter-e.m.f. voltage regulator

on the regulator panel. These switches are indicated by *M*, *N*, *P*, and *R* in Fig. 4. When a switch is thrown into the down position, the generator-field circuit is completed through the connection across the two bottom switch studs. This allows any generator to be hand-controlled when necessary. When the switches are thrown to the upper position, the field circuits are connected in parallel through the armature of the counter-e.m.f. motor. The blades of the switches are so designed that the circuit will be opened a small amount on one side before the blades make contact on the opposite side in order to prevent short-circuiting the armature of the counter-e.m.f. motor, when transferring from automatic to hand operation.

Effect of Change in Voltage

The main control magnet is connected to the busbars through resistance O-125 in the resistance box. Any slight change in voltage at the busbars will instantly be transmitted to the main control magnet. This magnet also carries an auxiliary winding, known as the speed or anti-hunting winding. In this installation this winding is connected in series with the shunt-field circuit of the counter-e.m.f. motor when the relay contact is closed. This winding is connected so as to have a differential effect with respect to the main winding and causes the main control contacts to operate with the desired rapidity.

A magnetic core *B* is suspended from the pivoted lever *A*. This core is directly above the stationary core *C* and is separated from it by a small air gap when in operation. The lever also carries the main control contacts and adjusting spring *D* to balance the magnetic pull between cores *B* and *C*. The contacts are so adjusted under this condition as to just barely make and break at the balanced pull. These contacts short-circuit the relay winding when they close. Limiting resistance *OR* in the resistance box prevents excessive current from flowing in the contact circuit. The relay and main-control contacts operate together, as the moment the main control contacts close the circuit across the relay winding, the relay spring *E* causes armature *G* to move upward and close the contacts. Resistance *RCRC* connected in series with a condenser across the relay contacts prevents excessive arcing at the contact tips.

The counter-e.m.f. motor is equipped with an eddy current brake. This brake consists of a low resistance metal disk that rotates in a strong magnetic field produced by magnets energized by the generator field current and by a shunt magnet connected across the motor armature. The brake is employed to prevent the motor from overspeeding and to give greater stability of rotation. The braking torque varies with the generator field current. This is very important, as much greater braking torque is required when operating with a high than with a low generator field current.

Switch *K* provides a means for connecting the external resistance *BB* in series with the shunt brake coil when operating with only one generator.

Cycle of Operations

Assume that the main control contacts are adjusted to hold 125 volts and that one generator is being used. Further assume that the field transfer switch, corresponding to this generator, has been thrown into the upper, or regulation, position and that the generator field rheostat is turned so as to give a voltage that would be higher than normal if the regulator was not used. The cycle of operation is then as follows:

The instant the field rheostat is turned out slightly, the main control contacts and relay contacts close owing to the increase in voltage. The relay contacts close the field circuit of the counter-e.m.f. motor, and a counter-e.m.f. is built up in the generator field circuit. This counter-voltage rises rapidly, backing down the generator field current until the busbar voltage is restored to normal. When the voltage lowers sufficiently, the contacts open, which in turn opens the

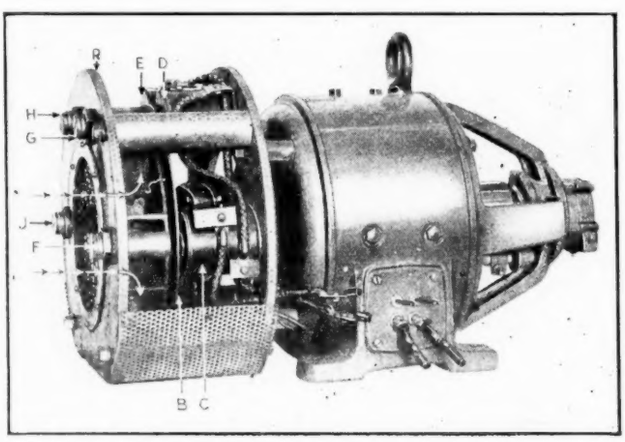


Fig. 3—Counter-e.m.f. motor with brake cover removed

regulator-motor field circuit and reduces the counter-e.m.f., and the generator field current increases. This causes the generator voltage to rise again slightly, and the cycle is repeated.

The contact action is so rapid that an average field is held on the counter-e.m.f. motor, which varies proportionately from time to time, with change of load or speed of the main generator. The anti-hunting winding causes the main control contacts to open rapidly after

they close and prevents the counter-e.m.f. from covering as wide a range as it otherwise would and improves the quality of regulation.

Circuit Breaker and Generator Shunt-Field Connections

When a regulator of this type is to be operated with two or more direct-current generators in parallel, care should be taken that the circuit breakers are interlocked to prevent excessive current in the field connections to the regulator when the breakers open with overload. The equivalent may be obtained by using one circuit breaker for each machine. This breaker should be installed in the line from the generator to which the shunt field is connected at the generator, as for example, breakers *S* in Fig. 4. If two circuit breakers are used and not interlocked, the one in the side of the line to which the shunt field is connected at the generator should be adjusted to trip out first in case the breakers open with overload.

The shunt-field lead for each generator, which is connected at the generator, should be made of the opposite polarity to the series field; that is, if the series field and equalizer connect to the negative terminal of the generator, the shunt-field connections at the generator should be positive.

When using one generator and putting the regulator into operation, the field transfer switch *M*, *N*, *P* or *R*, corresponding to the generator which is to be used, is put in the off, or non-regulating, position and the generator voltage raised to normal by means of the generator-field rheostat. The transfer switch should then be thrown into the regulating position, and this connects the armature of the counter-e.m.f. motor in series with the field of the generator. The generator field rheostat is then turned out slightly to a position that would raise the voltage a little above normal if the regulator were not connected. Assuming that the main control magnet is correctly adjusted for holding normal voltage, the contacts will now be closed, causing the motor to rotate and reduce the voltage to a point where the pull of the control magnet just balances the pull of the spring. It may then be necessary to raise or lower the control-magnet-spring adjusting screw slightly to obtain the desired voltage.

After the motor is running and the desired voltage has been obtained, the generator field rheostat should be turned to a point that will give between 20 and 35 volts drop across the armature of the regulator motor for a 125-volt generator.

To cut the regulator out of service, the rheostat should be moved back to a point corresponding to normal voltage and the transfer switch placed in the off position.

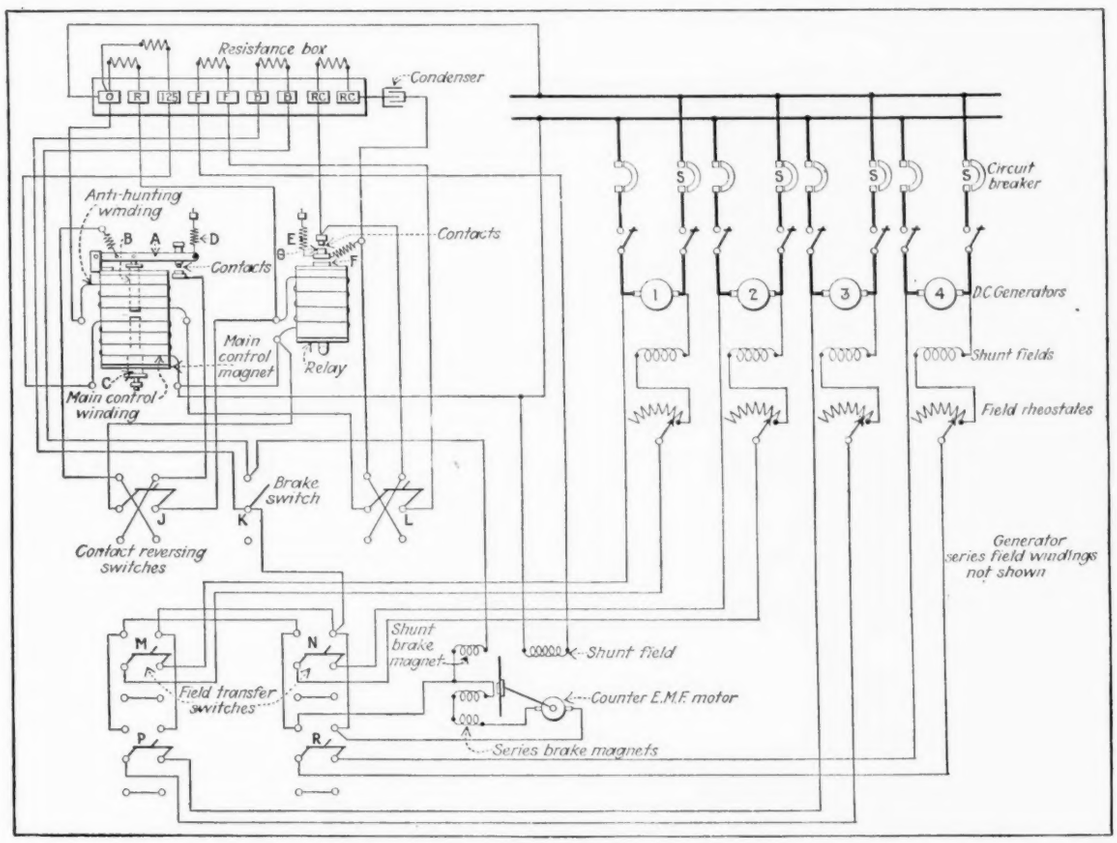


Fig. 4—Wiring diagram showing regulator connections

Parallel Operation of Generators

Before attempting to operate two or more compound-wound generators in parallel, the amount of compounding should be noted. To assure the best regulator operation, the voltage curve should droop slightly; that is, the effect of the series fields should be such that the voltage is not raised above the normal no-load value from no load to full load. If this is not found to be the case, the series-field shunt of each generator should be adjusted to produce the proper results. In case it is found necessary to readjust the shunts of several

generators that are to be operated in parallel, care should be exercised to adjust all shunts so that the compounding effect of the series fields of each machine is the same.

When more than one throw-over switch is provided, they are so interconnected that all the generator fields may be connected to the regulator at one time if desired. This method of operation gives the most satisfactory results as the field currents divide proportionately, which largely prevents load shifting after the generator-field rheostats have been properly adjusted.

Assuming that one generator is in operation with the regulator and that it is desired to connect the second generator in parallel its regulator field switch should first be thrown into the up position and the voltage adjusted by means of the field rheostat to correspond as closely as possible to the busbar voltage. The main generator switch should then be closed and the load division adjusted by means of the field rheostats, maintaining the proper voltage across the counter-e.m.f. motor armature.

When disconnecting one generator without interrupting the service, the best method is to reduce the load on the generator by means of its field rheostat and then to open the main generator circuit breaker and switch. After opening the generator circuit breakers and line switches, the regulator field switch, corresponding to the generator that is to be shut down, should be thrown to the hand-control position before the generator voltage is reduced below normal. This procedure is necessary in order to prevent the reversal of the generator field. It is not necessary to cut out the entire regulator when either paralleling or taking a machine off the line.

Main Control-Magnet Adjustments

When adjusting the main control magnet, the field transfer switch should be placed in the position for hand control and the generator voltage adjusted by means of the generator-field rheostat. With normal voltage on the generator the contacts should be nearly closed and the lever in a horizontal position. With an increase in voltage of 3 per cent, the upper core should come down and strike the lower stationary core. If this fails to occur at 3 per cent above normal voltage, the lower core may be turned in one direction or the other and the spring adjusted until the lever is in a horizontal position. The voltage can then be raised again to 3 per cent above normal, and the trip point checked. Adjustment of these cores is very important. It should also be certain that all the pivots are free and do not stick and that the magnet core hangs in the center of the magnet spool. A drop of oil on the pivots occasionally will prevent rusting and tend to improve operation.

In many cases, where there is a steady load and a slow-acting generator is used, the change in voltage causing the contacts to open and close may be made lower than 3 per cent if very accurate results are desired. The best value may be determined by trial, but should not be less than one per cent.

When an auxiliary relay is used, as in the case of large regulators, both core tips should be flush with the ends of the cores and the core-tip lock screws securely tightened. The pivot holder on the end of the armature is adjusted on the pivot until the armature stands directly over the core tip. The setscrews holding the pivots and the sockets are securely tightened and there should be no end play at these points, no pressure or binding action. These pivots and sockets are adjusted by loosening the setscrew and applying a light pressure with the fingers against the pivot socket, after which the setscrew is tightened. With the armature resting on the lower stop, the air gap between the core tip and the lower surface of the armature should be $\frac{3}{64}$ in. The pivot bearings should be oiled occasionally with light-grade oil to prevent them from rusting.

The distance between the relay contact tips should be $\frac{1}{32}$ in. when the armature is held down on the stop. All contact screws should be locked firmly.

The relay spring is adjusted so that the armature will remain in a central position between the lower stop and the upper contact with an applied voltage of 87 for a 125-volt generator, and 174 for a 250-volt generator, or in the same proportion for other generator voltages. When making this spring adjustment, a piece of insulating material should be placed between the main control contacts and the generator voltage adjusted to the desired value by means of the generator-field rheostat.

Regulator Motor

The details of the regulator motor brake construction are shown in Fig. 3. The brake disk *B* revolves in front of the four magnet pole faces and is attached to a fan that draws in air for cooling the disk. The three series brake magnets *C*, *D* and *E* are edgewise wound with varnish-treated copper strip, carry the total generator field current and are connected in series with the motor armature.

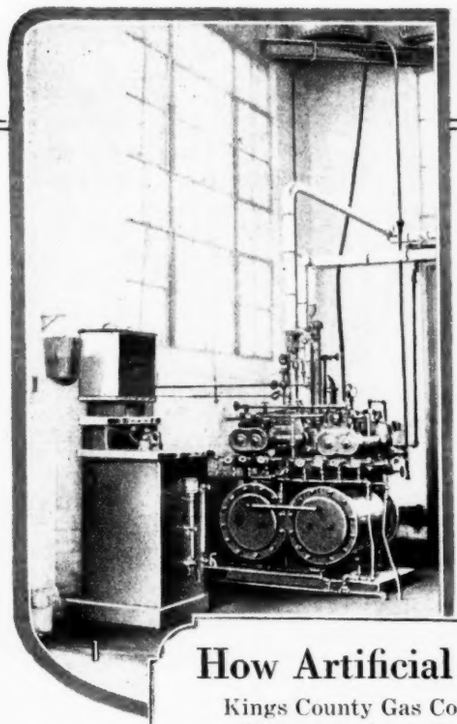
The braking effect can be varied by means of the air-gap adjusting screws *F*, *G*, *H* and *J*, which screw through the outer magnet ring *R* opposite each magnet. Decreasing the air gap increases the braking effect and vice versa. The shunt-magnet air gap should first be adjusted to allow the motor to speed up for maximum counter-e.m.f. with minimum generator field current, and the series-magnet air gaps then adjusted to allow the motor to generate maximum counter-e.m.f. with maximum generator-field current. After the air gaps have been properly adjusted once, no further attention will be necessary. This motor is equipped with ball bearings on both ends to take up the slight end thrust produced by the eddy-current brake.

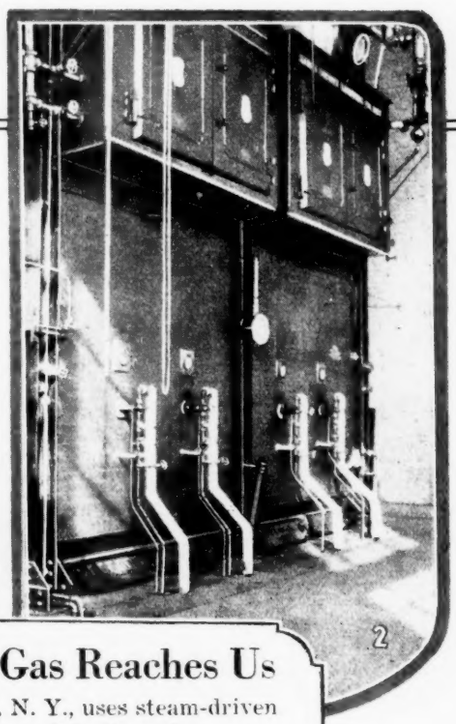
The care necessary in connection with a regulator of this kind is small, the contacts and motor brushes being practically the only points requiring attention except at long intervals. The fact that regulators of this kind have very few operating contacts and can be applied to generators of the largest size appeals to practical power-station operators.

Steam Power Charts Available

In the June 30, 1925, issue there appeared a new type of chart for the rapid determination of the steam consumption of a perfect engine or turbine for any given initial pressure and superheat and any back pressure. A still simpler pictorial chart, published in the Dec. 1 issue, is useful for rough estimates of the power obtainable from a given flow of steam.

Reprints of both charts have been made on cardboard. While they last single copies of one or both will be sent free on request to *Power* subscribers. Refer to the first as "Steam Consumption Chart" and the second as "Horsepower Chart."





How Artificial Gas Reaches Us

Kings County Gas Co., N. Y., uses steam-driven gas blowers to force the gas into its mains.

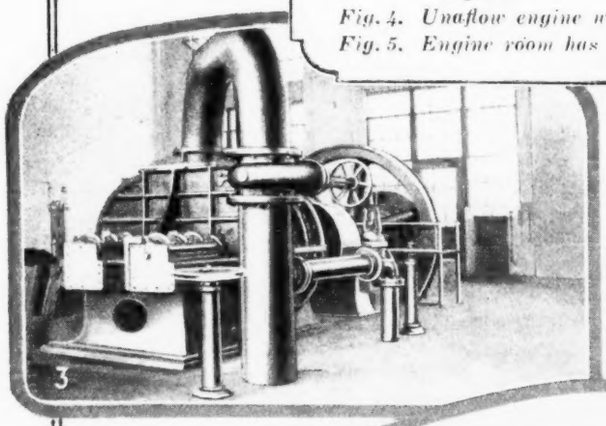
Fig. 1. Oil pumping apparatus

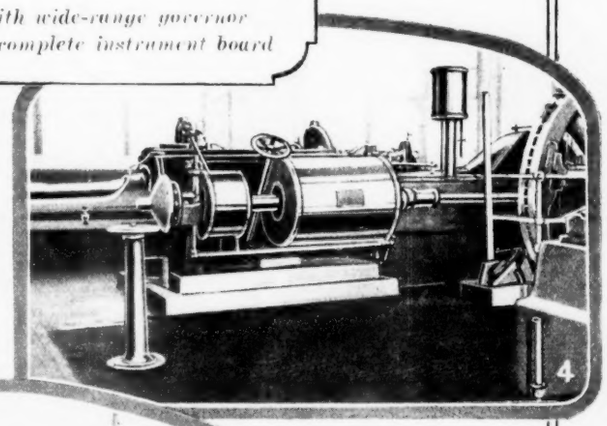
Fig. 2. Vertical water-tube boilers are equipped with oil burners

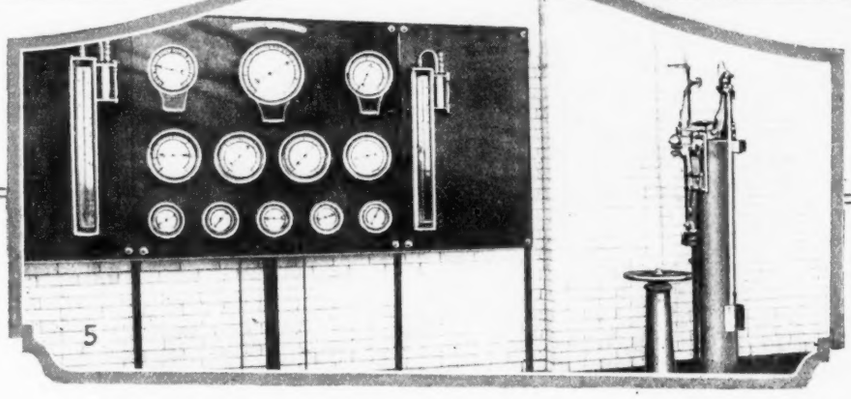
Fig. 3. Positive blowers are direct connected to steam engines

Fig. 4. Unaflow engine with wide-range governor

Fig. 5. Engine room has complete instrument board







Ammonia Condenser Construction and Operation*

MAIN types of condensers, their construction, operation and care, with summary of factors to be considered in their selection.

By H. J. HALTERMAN

THE function of the ammonia condenser is to remove the heat taken up in the evaporator side of the system and the heat added during the process of compression, and to change the ammonia vapor back to a liquid state. In the design of the condenser the principle of the steam condenser has been followed. Atmospheric and double-pipe condensers with various arrangements of the gas inlet and liquid outlet are the most common.

Atmospheric Condensers

The standard atmospheric condenser is generally built up of twelve 2-in. pipes, placed one above the other. The ammonia gas from the compressor is admitted at the top, and the liquid is drawn off from the bottom. Water is distributed over the top pipes by slotted or perforated pipes, or by V-shaped distributing troughs, and trickles down over the succeeding pipes in a thin film, flowing in the same direction as the gas. Where this apparatus can be installed to allow a free circulation of air around the coils and where it is not necessary to conserve space, it is a popular condenser. On account of its parallel-flow principle the liquid is not cooled as near the temperature of the water going on the condenser as in many other types. However, its adaptability to use with any kind of water, as well as the accessibility for inspection and cleaning, make it the choice for a great many installations.

There have been a great many variations in the arrangement of the cooling surface, all of which add complications to the operation of the condenser. In some cases the hot gas enters at the bottom of the condenser, meeting the water going off, and passes through the four bottom pipes, which act as a precooler. It is then conducted to the top of the condenser, and flows down through the pipes paralleling the water. The liquid is drained off from the pipe at the bottom of the condenser, immediately above the precooler section. Another arrangement sometimes used is to install extra stands of condenser through which the hot gas passes before it reaches the main condenser. The greatest economy is gained with the hot-gas cooler when using the water off the main condenser over the desuperheating coils.

Bleeder and Double-Pipe Condensers

To obtain a counterflow effect in the atmospheric condenser, the bleeder type was developed. The gas enters the bottom coils of the condenser and is condensed as it rises. Bleeder connections are arranged at suitable points on the condenser to drain off the liquid as it condenses. The velocity of the gas carries any air or other noncondensible gas to the top coils, which are equipped with vent or purge connections.

Whenever the quality of the cooling water will permit, and it is to be used for other purposes, the double-pipe condenser is a desirable type. It generally consists of 1¼-in. tubes placed inside of 2-in. pipes. The ammonia enters the top of the condenser, flows through the annular space between the inner and outer pipes, and the liquid is drained off at the bottom. The water enters the bottom of the condenser and flows through the inner pipes. The hot gas comes in contact with the water leaving the condenser, and the liquid ammonia meets the cold water coming in.

Owing to the counterflow principle the liquid is cooled nearly to the initial temperature of the condenser water. This is probably the best and simplest all-around condenser for small installations. Precaution must be taken to avoid accumulations of scale. Sediment may be washed out of the tubes by reversing the direction of the flow of the water. If the condenser is back-washed periodically and a jet of air is blown into the water while back-washing, the tubes can be kept fairly clean, even with a poor quality of water. As it is difficult to detect leaks in the tubes, the water leaving the condenser should be tested occasionally with ammonia test paper or with Nessler's solution.

This condenser is arranged also to operate flooded, the object being to keep the ammonia side of the coils wet. However, this arrangement only seems to complicate the condenser.

Multi-tube Condensers

A type giving satisfactory results is the multi-tube condenser. It consists of an outer pipe about 8 in. in diameter with tube heads welded to each end. About seven 2-in. tubes are expanded into these heads. The large pipes are placed one above the other and connected by return bends. The gas enters the top pipe and circulates around the tubes, and the liquid is drained off at the bottom, the same as in the double-pipe condenser. The water enters at the bottom of the condenser and flows through the tubes and return bends and out at the top, giving the counter-current effect desired. The liquid is cooled to within a few degrees of the temperature of the water going on. This condenser requires less space than either the atmospheric or double-pipe type.

A special design of the multi-tube condenser is the multi-pass type. In place of the water return bends a special baffled water bend is bolted to each end of the condenser unit. The water on the condenser enters at one end of the unit, flows through one tube, then through the water head, back through another tube and so on until it has traversed the length of the condenser through each tube in the unit and flows out at the opposite end into the water outlet header. The flow of gas is the same as in the single-pass multi-tube condenser.

The shell-and-tube condenser recently has gained much favor among refrigerating engineers. It is set

*From a paper presented at sixteenth annual convention of the National Association of Practical Refrigerating Engineers, Detroit, Dec. 8-12, 1925.

either horizontally or vertically, the latter type being used most commonly on account of the small amount of floor space required and the better control of the circulating water. It is constructed of a vertical cylinder containing a number of 2-in. tubes to give it the necessary cooling surface. These tubes are rolled into the tube heads at each end of the condenser. The gas enters the shell and surrounds the tubes. The liquid is drawn off near the bottom of the shell. The water is admitted at the top of the tubes by means of water-distributing devices that allow a film of water to flow down the inside of the tubes. Where distributing plugs or thimbles are used, the water is given a spiral motion as it descends. The water flows in the same direction as the ammonia, but owing to the high rate of heat transfer the liquid is cooled to a temperature very near that of the water going on. This condenser is adaptable for use with almost any kind of water and is easily accessible for inspection and cleaning. Leaks around the top ends of the tubes are readily detected.

This condenser is sometimes arranged to admit the cooling water at the bottom, giving it the counterflow effect and allowing for the re-use of the cooling water without additional pumping. With this arrangement a large quantity of water is required on account of the decreased velocity. It may be possible to overcome this difficulty by inserting a core in the shape of a helix in each tube to create an annular space between the tube and the core, through which the water is given a spiral motion.

Submerged condensers either of the tank-and-flat-coil or tank-and-spiral-coil type are seldom used except on small units, on account of the low rate of heat transfer, due to the poor circulation of water around the coils.

Choice of Condensers

There are many factors that may enter into the choice of condensers, such as the quality and quantity of circulating water available, the cost of pumping, the location of the condenser or the available space. The comparative condensing surface requirements of the main classes of ammonia condenser are approximately in the ratio of 1, 2 and 3 for double-pipe, shell-and-tube, and atmospheric, respectively. The vertical shell-and-tube condenser requires the least amount of floor space, the multi-tube next, then the double-pipe, and the atmospheric condenser. The approximate cooling surface and floor-space requirements are as given in the accompanying table, the figures being based on 150 tons of refrigeration, 70-deg. cooling water, and 4 gal. of water per minute per ton.

COMPARATIVE CONDENSER SURFACE AND FLOOR SPACE

Type of Condenser	Number of Stands	Cooling Surface, Sq.Ft.	Floor Space, Sq.Ft.
Shell and tube	2 shells,	2,400	50
Multi-tube	3	1200	100
Double pipe	15	1,200	400
Atmospheric	30	3,750	800

Operation of Condensers

To obtain economical operation in any type of ammonia condenser, it is essential that the water surfaces be kept free from foreign deposits such as slime, mud or scale. The ammonia side of the pipes should not be allowed to accumulate oil or non-condensible gases. A gas or oil film on the ammonia surface or a scale forming deposit on the water surface retards the flow of heat and by permitting the condenser pressure to rise, increases the power required by the compressor.

The accumulation of scale on the atmospheric condenser may be prevented by brushing the coil surfaces with a stiff brush while the condenser is operating. A rasp or a scraper ground out to span one-half of a 1¼-in. pipe, is an effective tool for cleaning the tubes.

In case of scale formation in the double-pipe condenser, it generally can be removed by a round stiff wire brush attached to the end of a ½-in. pipe and pushed through the tubes. If the scale is hard or thick, it can be removed by a rotary tube cleaner or a drill fastened on the end of a piece of pipe and driven through the tube. The condenser always should be washed thoroughly after it has been cleaned before the return bends have been replaced.

The vertical shell-and-tube condenser can be cleaned while in operation. It is necessary only to remove the water-distributing device from one tube at a time, punch the tube, and replace the thimble or ferrule.

Effect of Foreign Gases

Foreign gases in the condenser cause a great power loss. Air gets into the system in various ways. Non-condensible gas is indicated by a high condenser pressure. This pressure under normal conditions should be the pressure corresponding to a condensing temperature 10 to 15 deg. above the water going on the condenser. Every plant should be arranged to eliminate the non-condensible gases from the system. In many of the older plants purging connections were made only at the top of the condenser, regardless of the type of condenser used. Recently, it has been discovered that in most cases the non-condensible gas is carried down to the liquid receiver by the velocity of the ammonia through the condenser. Exceptions to this are in the bleeder type and other upward-flow condensers.

The old method of removing non-condensible gases was to attach a hose to the purge line and insert the end of the hose in a pail of water. This method is still in use in many plants. The purge valve is opened slightly and the non-condensible gas bubbles up through the water. When the ammonia begins to escape, it is absorbed by the water, producing a cracking or frying noise similar to that made by steam discharging into a vessel of water. The purge valve is then closed.

A more economical and effective method of purging is by the use of a non-condensible gas separator. This apparatus consists of an evaporator coil inside a cylinder. The cylinder is first partly filled with liquid ammonia which is cooled to near the temperature of the low-pressure gas. Then the non-condensible gases are allowed to percolate up through the cold liquid ammonia, and escape through an automatic valve on top of the cylinder.

The importance of keeping the condenser pressure as low as possible cannot be emphasized too much. The saving of 1 per cent of the power required to drive the compressor, for every 2-lb. reduction in the condenser pressure, indicates the necessity of keeping the condenser clean and free from non-condensible gases.

A convenient rule to remember is that the condenser pressure is approximately 2 lb. gage for 1 deg. F. of temperature of the water going on the condenser plus 20 lb. With the compressor running, the pressure should be, nearly: For 50-deg. water, 120 lb.; 60-deg., 140 lb.; 70-deg., 160 lb.; 80-deg., 180 lb.; and 90-deg., 200 lb.

If the condenser pressure is in excess of that for the given initial water temperature, it is an indication of the presence of non-condensible gases.

A New Line of Small Turbines

By R. R. LEWIS
General Electric Company

DESCRIPTION of a series of small turbines recently developed by the General Electric Company to meet a demand for small units of refined design.

TURBINES of small capacity, such as from 25 to 200 kw., as a rule are of relatively simple design to meet the principal requirement of low first cost. In general the efficiency is not of first importance, as the total amount of steam used is small, and in many cases the heat in the exhaust steam is recovered.

However, many cases arise where it seems desirable to use small turbines of a greater degree of refinement in design and finish. To meet this demand there has recently been developed a series of small steam turbines designed to meet the severest requirements of reliability, low upkeep, efficiency and long life.

These turbines are used not only for driving electric generators, both alternating and direct current, but also for driving centrifugal pumps and for other mechanical applications.

An alternating-current generator set of 200-kw. capacity is shown in Fig. 1. The turbine and generator are bolted to a substantial tie piece forming a so-called "rigid frame" set without bedplate. This construction is typical of a large number of turbines of sizes up to 3,000 kw. built by the General Electric Co. during the last fifteen years. The generator rests on a sole plate bolted to the foundation, and the head end of the turbine is supported on flexible iron plate, which provides for both axial and radial expansion and contraction due to changes in temperature of the turbine casing. As this supporting piece is attached practically at the central plane of the turbine, the casing expands upward and downward from this plane without disturbing the position of the shaft. This construction is made plain in Fig. 2.

The wheel casing is completely divided horizontally at the center line. This also applies to the bearing linings, packing boxes and diaphragms. In this way inspection of the interior is greatly simplified and removal of the rotor is an easy matter. This effect is further assisted by placing the steam inlet and exhaust connections on the lower half of the turbine so that steam joints do not have to be broken to get at the inside of the turbine.

The turbine shaft is made of heat-treated nickel steel and rests in two ball-seated babbitt-lined bearings arranged for water cooling as required. A balancing ring is placed on the shaft next to each bearing, so that if any tendency to vibrate should develop after the turbine has been placed in service, it is a simple matter, by the use of this balancing ring, to restore perfect balance.

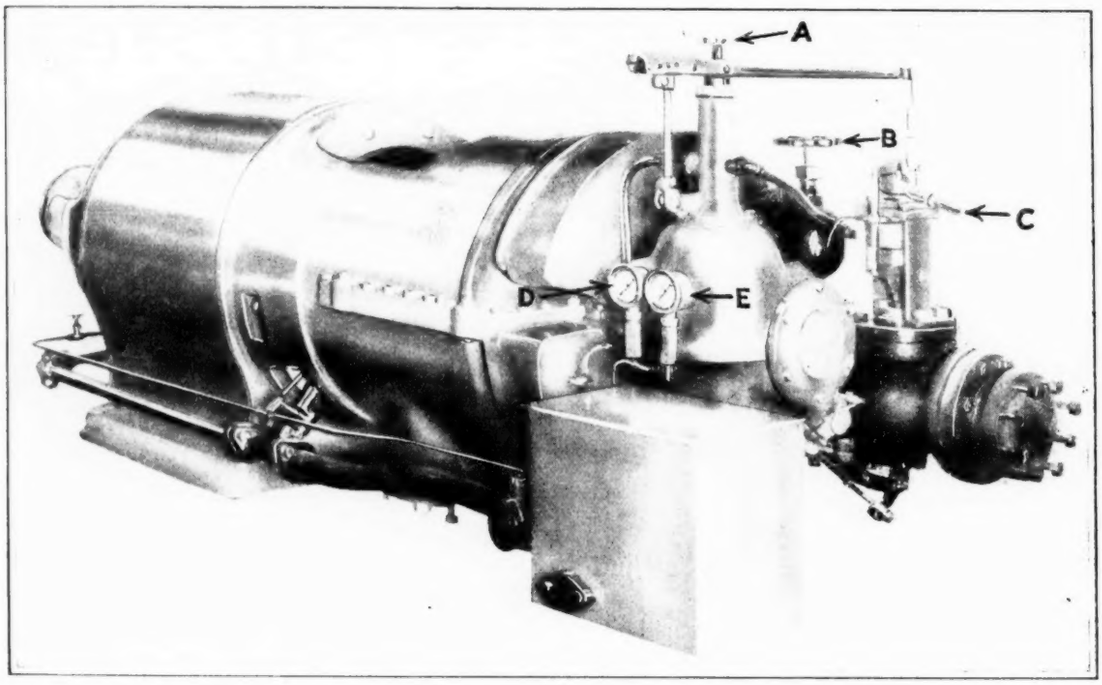


Fig. 1—A 200-kw. turbine-alternator unit

The hand synchronizing wheel *A* adjusts the pilot-valve bushing. *B* is a hand valve for a group of nozzles. The starting lever *C* opens the steam valve with the governor stationary. *D* and *E* are oil-pressure gages for the governor and lubricating systems.

The wheels are turned from steel forgings, and the buckets are attached by means of dovetails.

Steam entering the turbine passes first through the stop valve, then through a strainer of monel wire gauze, the governor valve, and emergency quick-closing valve, whence it passes to the steam ring for distribution to the various groups of first-stage nozzles.

The emergency valve is entirely separate from the governor valve and may be tripped by hand, but is normally operated only by the emergency governor mounted at the end of the turbine shaft and adjusted to operate at about 10 per cent above the running speed.

Geared to the main turbine shaft is a secondary vertical shaft turning at reduced speed. On the upper end of this shaft the centrifugal speed governor is varying centrifugal force dependent upon the speed of the turbine.

The pilot valve is tubular in form, and slides up and down in the pilot-valve bushing which in turn slides up and down in the pilot-valve housing. Oil ports are provided through the walls of the bushing, and these ports are covered to a greater or less extent by the upper portion of the pilot valve. All the oil passing through the ports goes through the tubular pilot valve and back to the oil reservoir.

Keeping in mind the fact that the oil that is allowed to pass through the ports in the pilot-valve bushing is withdrawn from the oil pipe leading from the oil pump to the operating cylinder on the governor valve, it will be realized that a partial restriction of this flow will

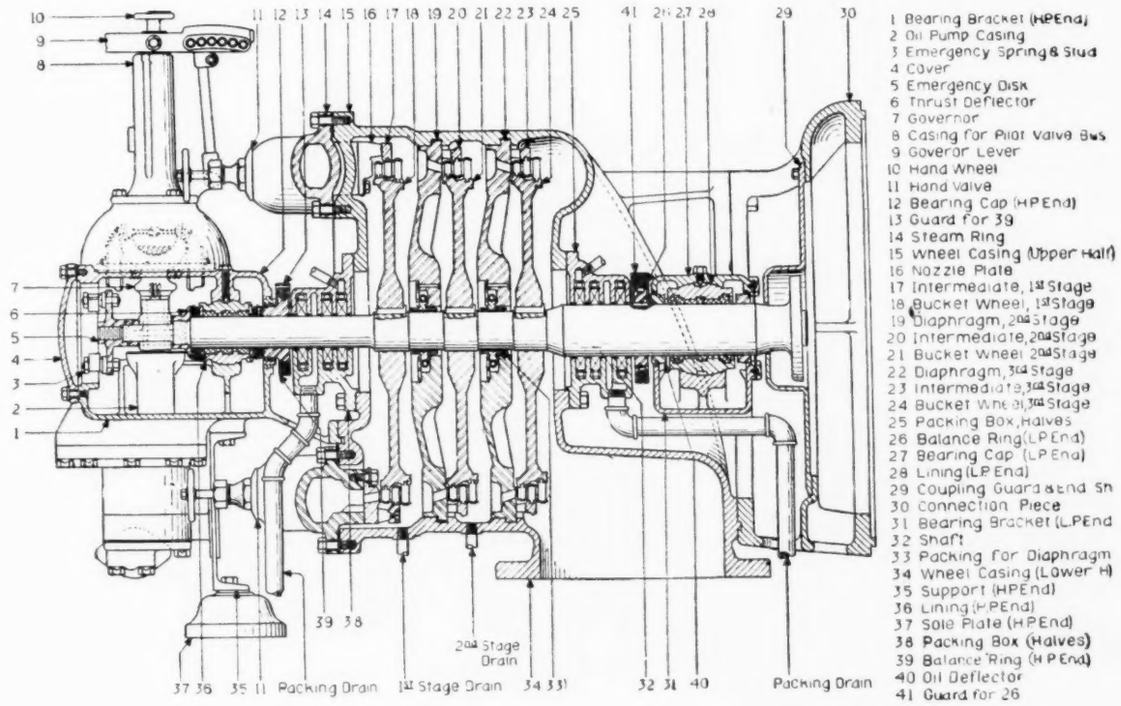


Fig. 2—The design of the turbine embodies features not usually found in small machines

mounted, and at its lower end is a gear-type oil pump supplying oil under pressure, both to the bearings and to the oil-operated governor valve mechanism.

An oil cylinder is mounted immediately above the governor valve body (Fig. 3). From a piston in the oil cylinder a piston rod is yoked to the stem of the double-ported steam admission valve which controls the amount of steam admitted to the turbine.

Oil pressure under the piston raises and opens the valve, as required, and a helical compression spring pressing on the top of the piston closes the valve when the oil pressure is withdrawn.

The piston is supplied with oil under pressure from the oil pump through a pipe containing an orifice to regulate the maximum flow. Between the orifice and the cylinder a branch in the oil pipe connects to the pilot-valve housing, and it is the function of the pilot valve to control the flow of oil at this point back to the oil reservoir.

The pilot valve is linked to the governor weights and revolves with them; it also is moved down or up by the weights as these extend or withdraw, owing to the cause a building up of pressure in the operating cylinder and a corresponding opening of the steam valve.

The absolute position of the pilot valve is determined solely by the position of the governor weights and the speed of the turbine. The absolute position of the pilot-valve bushing is determined in two ways, first, by a handwheel adjustment for synchronizing purposes, and second, by a lever connecting the bushing to the piston rod of the operating cylinder, so that for each new position of the governor valve a corresponding new position is given to the pilot-valve bushing. This restoring mechanism automatically re-turns the pilot-valve bushing to a neutral position with respect to the pilot valve after any change of load.

The shaft of the turbine is connected to that of the generator field by a forged-on flange coupling. The laminated iron of the field is assembled on the shaft and clamped between steel plates. The field windings are placed in slots provided in the laminations and held in place by metal wedges. The end turns of the windings are retained in place by steel shrink rings.

The field is fitted at both ends with fans which draw

ventilating air into both ends of the generator, and the air is forced over the surface of the field through the air gap between field and armature and outward through a number of ducts placed at intervals in the armature sheet-iron stacking.

The armature consists essentially of a cast-iron frame holding the slotted laminations and the windings embedded in the slots. The armature is usually wound for 240, 480 or 600 volts for local lighting or for industrial plants, or for 2,300 volts where distribution is to be made over a large area.

The generator is usually fitted with a direct-connected exciter which is mounted in a bracket extension from the armature.

This turbine is also furnished for driving pumps, direct-current machinery and other equipment, through gears, if necessary. Dual drive service is entirely practicable also, this turbine on one end of a pump or exciter shaft sharing the load with a motor on the other end. By proper division of load between turbine and motor, exhaust-steam supply and demand can readily be balanced.

A small member of this turbine family, running at about 4,500 r.p.m., drives through a reduction gear a 50-kw. 60-cycle generator at 1,200 r.p.m. The generator is equipped with a direct-connected exciter. Such a set is very useful for carrying the lighting load at night and on Sunday when the main units of a factory plant are shut down. The exhaust steam from the turbine may be turned into the heating system.

In many instances, particularly for the smaller mechanical drives, it is unnecessary to use the oil governor,

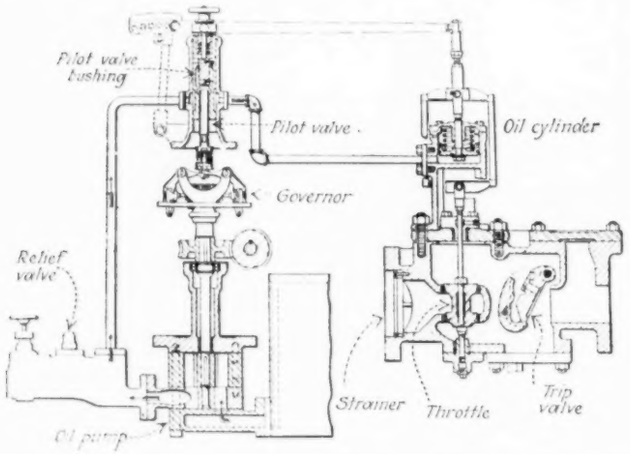


Fig. 3—The hydraulic relay governor is of the "leak-off" type. Oil pressure in the operating cylinder is controlled by a bleeder pilot valve

and in its place a direct-acting centrifugal governor is mounted on the end of the turbine shaft. Fig. 4 shows such a unit. The governor operates the steam admission valve through a suitable arrangement of cranks.

A modification of this method of control is to omit the centrifugal governor and to mount a pump governor directly on top of the governor valve body. This pump governor acts to maintain such speed of turbine and pump that a constant difference of pressure will be held between the pressure at the outlet nozzle of the pump and the pressure at some point in the pipe from the pump, as for instance, at the boiler in the case of boiler feed.

In general these turbines can be arranged for steam pressures up to 400 lb. per sq.in. gage and total steam temperatures up to 650 deg. F., for either non-condensing or condensing operation. Usually, a non-condensing turbine will have one or two stages, and a condensing machine three stages.

For direct connection to 60-cycle generators the speed is 3,600 r.p.m., while for other drives the speed may

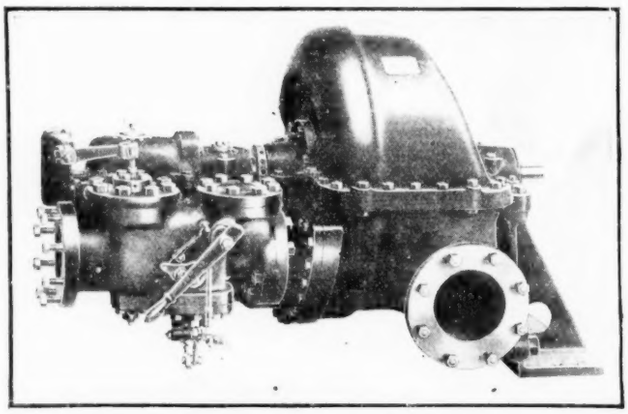


Fig. 4—Small turbines may be equipped with a simple throttling governor

be anywhere from 1,000 to 5,000 r.p.m. to meet the requirements of the case.

For best efficiency of operation over a wide range of loads or where the steam conditions vary, it is desirable to furnish one or more hand valves, which serve to cover or uncover portions of the belt of first-stage nozzles. The best efficiency is obtained when only a sufficient number of nozzles are in use to carry the load when these nozzles are functioning at full steam pressure. The governor valve will then be wide open. For the same conditions any addition to this number of nozzles would cause all the nozzles to operate at reduced steam pressure and hence at reduced efficiency. As additional nozzles are opened up, the turbine speed tends to rise, and the governor checks it by partly closing the throttle.

On the other hand, if the steam pressure is below standard, additional nozzles must be opened if the turbine is to carry its load. Such valves also provide for occasional heavy loads, without the loss incident to the continuous operation of an underloaded machine. Whatever the setting of the hand valves, all steam entering the turbine is under governor control.

It is foolish to buy a trap by the pipe size with no thought as to the quantity of water to be handled. Capacity tests of various makes of 1¼-in. traps at the Naval Engineering Experiment Station, with 250 lb. pressure, showed a variation in capacity from 2,300 to 26,000 lb. per hour. In other words, some of the traps had over ten times the capacity of others with the same size of pipe connection. The discharge under a given pressure is determined, not by the pipe size, but by the area of the orifice, which is quite a different matter. When steam is on the line or piece of apparatus, the simplest way to find the amount of condensation is to measure it directly, using a graduated measure or bucket and scales.

Gears for Speed Reduction

Discussion of Types of Gear Drives—Applications in the Power Plant

WITH the exception of centrifugal pumps and generators it is seldom that the machines operate at a speed permitting direct connection to the driving motor or engine. To accommodate this speed discrepancy, gears are coming more in evidence in and around the power plant.

The wide range of service conditions encountered has resulted in the development of many different forms of gear train. These may be classified as: Simple spur, bevel or miter, helical, herringbone, worm, compound worm, compound herringbone, compound spur, and planetary.

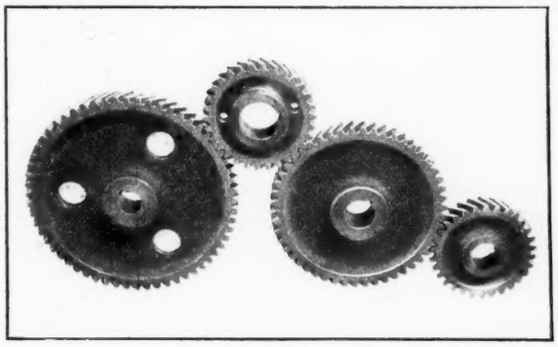


Fig. 1—Helical Gear Train

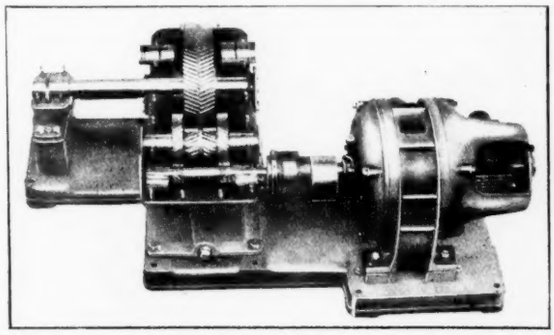


Fig. 3—Compound Herringbone Gear Set

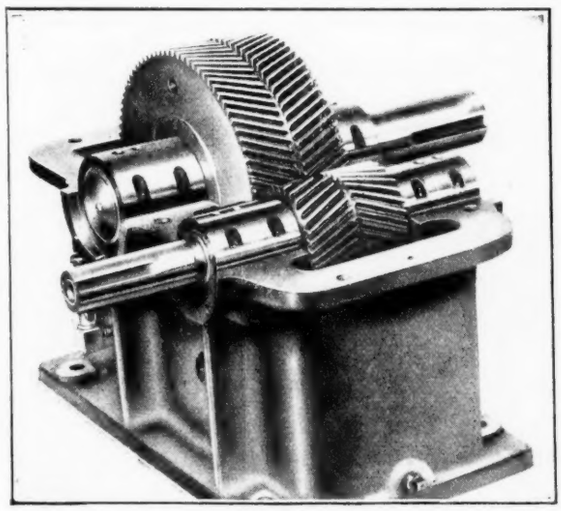


Fig. 2—Herringbone Gear Unit

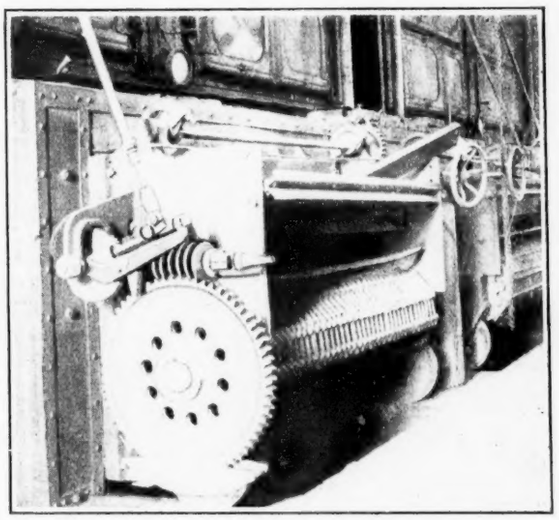


Fig. 4—Cast worm used for stoker drive

If floor restrictions do not prevent and if the gear ratio is not higher than 10 to 1, the simple spur gear is comparatively cheap and efficient. If a uniform velocity is necessary, the spur gear is not so desirable as the helical. This type, illustrated in Fig. 1, insures that the teeth will come into contact with less chatter and as indicated, gives a more uniform velocity. Such gears have the objection that the skew form of tooth sets up a thrust parallel to the shaft, and this must be taken up by some form of thrust bearing. Consequently it is common to use a combination of a right- and left-hand helical gear to avoid this end thrust, as shown in Fig. 2. It was the desirability of avoiding end thrust that led to the development of the herringbone gear. The herringbone is an expensive mechanism inasmuch as the cutting of the teeth calls for a high degree of accuracy. In fact, during the war, when many reduction gears were required for marine-turbine drives, only a few firms were in a position to produce serviceable units. Very high gear ratios are possible; for example, on the steamship "Mololo" the gears between turbines and propellers have a ratio of 120 to 1.

The helical and herringbone differ from the spur gear in having a finer tooth pitch, usually a greater width of face, and a higher tooth pressure. To insure satisfactory results, the shafts must be parallel and be rigidly supported. In addition, the center-to-center distances must be correct and be maintained at the original value.

The efficiency of the herringbone for ratios up to 10

to 1 is approximately 98 per cent; at greater ratios the efficiency drops off a slight amount, but should always be above 96 per cent.

When two shafts are not parallel and are not in the same plane, a worm gear is frequently used. In the past the worm was held in low repute inasmuch as its efficiency was below 50 per cent and the mechanism was self-locking, that is, would not work in the reverse direction. Of late years this mechanism has been developed to a point where it is practically as efficient as other types of gearing.

For heavy service, as for stoker drives such as shown in Fig. 4, cast worm gears are common practice. The speed is low and inexpensive cast set is serviceable. For higher-speed drives the machine-cut worm is rapidly coming to the front. Many units such as is shown in Fig. 5, and of late compound worm-gear units have been developed for high speed ratios, the assembly consisting of a high-speed worm meshing with a gear fixed on a shaft to which is also keyed a slow-speed worm meshing with the slow-speed gear.

In many installations the driving- and driven-shaft axes coincide. Consequently, none of the gear arrangements touched upon can be used and recourse is had to a spur-gear speed-reducing unit.

These units fall into two classes—planetary and non-planetary types.

One type of non-planetary gear set is an assembly of spur gears so arranged that the two shaft axes coincide. The automobile transmission gear is a familiar example. For heavy work the gears and case are more rugged, as will be seen from Fig. 6. This gear has two main merits. The two shafts have bearings at each end of the case; at one end one shaft fits into a recess in the second. By replacing the secondary gears, almost any reduction can be obtained with a machine already installed.

A second non-planetary unit is made up of a high-speed pinion driving three intermediate spur gears mounted upon the stationary end of the housing; these gears in turn mesh with and drive a revolving internal gear ring which is fastened to the driven shaft by some form of web or spider.

In the unit shown in Fig. 7, a double reduction is

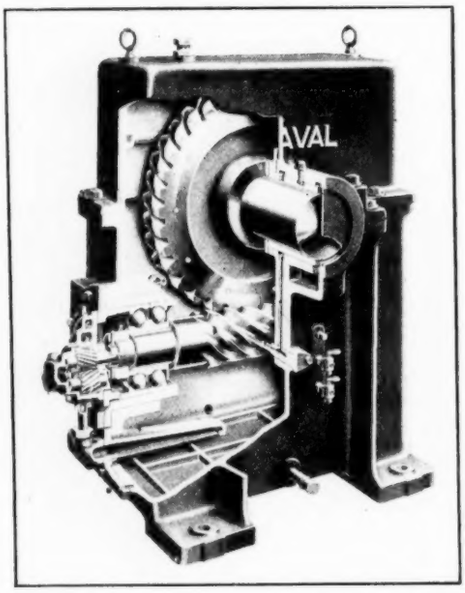


Fig. 5—Machine cut worm and gear unit

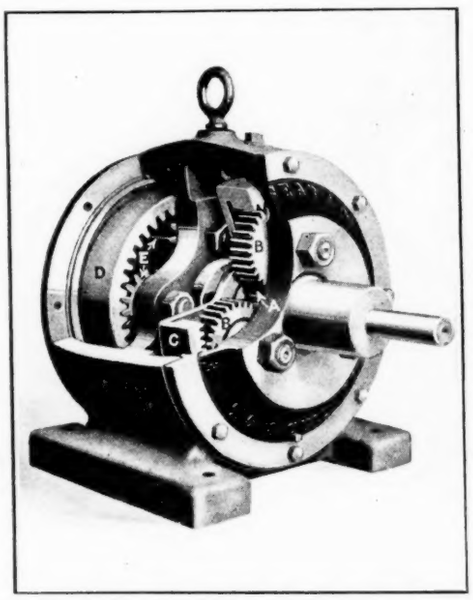


Fig. 7—Non-planetary speed reducing unit

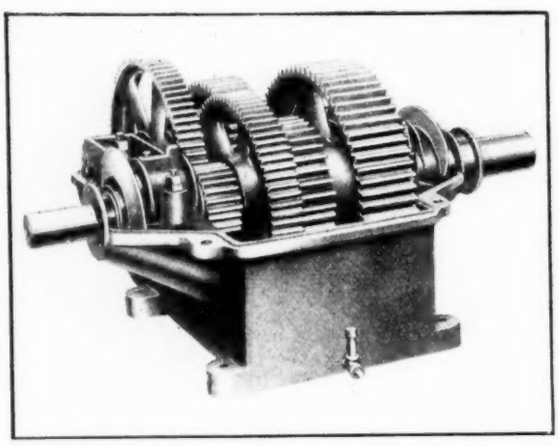


Fig. 6—Spur gear speed reducing set

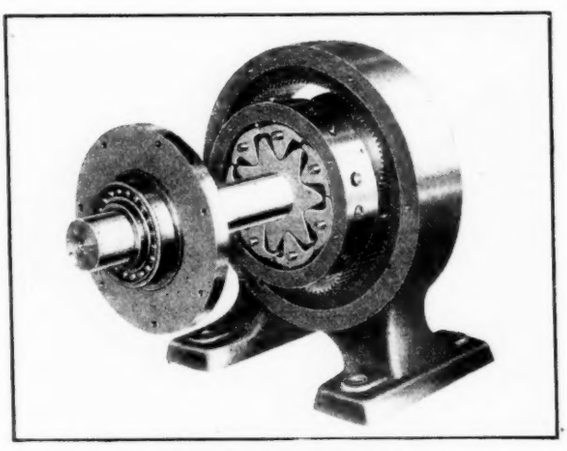


Fig. 8—Planetary gear speed reducer

obtained. The driving pinion *A* meshes with three fixed journal pinions *B* driving an internal gear *C* which is keyed to a short shaft carrying a pinion in the second compartment. This latter pinion in turn drives the internal gear *D* through the pinions *E*, the gear *D* being mounted on the driven shaft.

In another form the rotating spider is done away with and the three gears meshing with the driving pinion are mounted on short shafts, each carrying a pinion which in turn meshes with the gear on the driven shaft.

In the planetary type, Fig. 8, the driving pinion engages three pinions mounted on a spider which is keyed to the driven shaft. These three pinions also mesh with an internal gear ring held fast in the housing. The rotation of the driving pinion causes the three pinions to revolve, and as these pinions are meshing with the fixed gear they are constrained to advance as they rotate, which causes the spider and driven shaft to rotate.

The speed-reduction units have the common advantages of being dustproof and further eliminate all danger of workmen being caught in the gear.

Better Condenser Performance Through Keeping Down Air Leakage

By F. E. Murphy*

One of the principal causes of poor condenser performance is air infiltration. The power-plant operator seeking to improve the economy of his plant would do well to investigate this feature.

Before the advent of the air meter for measuring the air extracted from the condenser, the work involved in determining this factor was so costly that it seldom was attempted. Consequently, the allowance made for air infiltration when figuring air-pump capacity was arrived at more by conjecture than by knowledge.

At present several types of air-leakage meters are being manufactured. These instruments are accurate within a small percentage and their operation is simple. They are easily adaptable on installations where steam-jet air pumps are used. Every condenser installation should include an air meter, and the air leakage should be included in the daily log readings.

We know from experience that it is feasible to keep the air leakage down to approximately 2 to 3 cu.ft. per minute for 20,000-sq.ft. condensers, 5 to 6 for 30,000-sq.ft., and 10 to 12 for 50,000-sq.ft., and every effort should be made to keep within these limits, because, for every pound of air removed, the air pump is called upon to handle approximately two pounds of steam.

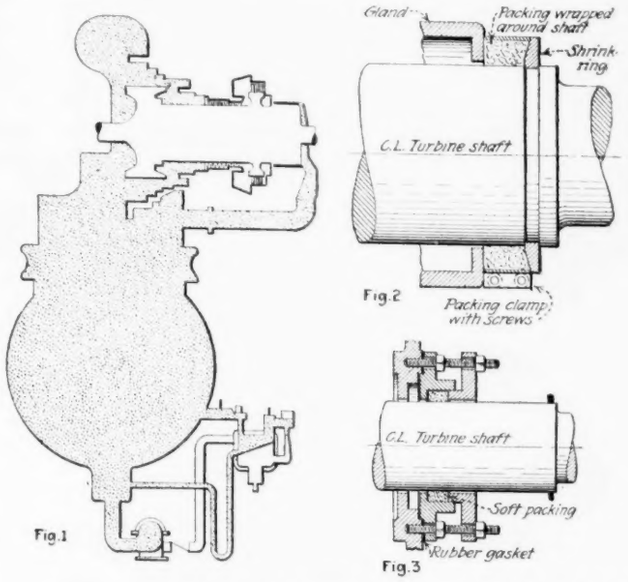
Air infiltration occurs through the condenser shell joints, through the turbine casing joints, where pressures exist lower than atmospheric pressure, through the turbine and condenser shell casting pores, through the piping connection joints, through the valve-stem glands, under the atmospheric relief valve seat and through the turbine shaft glands.

Fig. 1 shows a cross-section through a turbine and condenser installation. The shading indicates where pressures lower than atmospheric exist during normal operating loads.

When making up the condenser-shell joints, a gasket material should be used that will not bake out at temperatures as high as 225 deg. F. Canvas boiled in linseed oil and applied with either white or red lead makes a very good joint. A coat of bituminous paint applied when the system is under vacuum will reduce the air infiltration through the casting pores. Piping with screwed flanges should never be used for vacuum service unless the flanges are welded to the pipe. Ordinary screwed pipe is very hard to keep tight.

Valve-stem glands should be gone over at regular intervals. The atmospheric relief valve seat should be water-sealed. No trouble will be experienced with the turbine glands if the sealing pressure is kept as specified by the turbine manufacturer.

It is the policy of all condenser builders to put a hydrostatic test on the condenser after it has been



In Fig. 1 the shading shows the portions of turbine, condenser, and pump casings which are normally subject to vacuum. Figs. 2 and 3 show special shaft packing for testing the turbine casing for leaks.

erected and the piping installed. This test includes all parts of the system below the turbine exhaust nozzle which is under vacuum during operation. The possibility of excessive air leakage in a new condenser installation is thus practically eliminated. There remains, however, a considerable portion of the turbine subject to vacuum which is seldom, if ever, given a hydrostatic test after erection.

A hydrostatic test could be applied to the turbine casing with slight additional cost, and this should be done before the insulation and lagging are applied and before steam is turned into the turbine. A sealing ring for preventing gland leakage can easily be made to fit around the turbine shaft for use during the test. Fig. 2 shows such a ring. Turbines having glands that can be removed without lifting the top half of the turbine casing can be equipped with an auxiliary gland for use during the test. Fig. 3 shows such a gland.

The additional cost of furnishing the sealing rings and testing the turbine casing will be very small compared with the amount often spent in locating air leaks in new installations. The writer has in mind a number of cases where two or three weeks were required to locate the leaks.

*General superintendent of erection, Elliott Company.

Clean Air Needed for Engines

By G. Grow

WHILE it is seldom that there is enough grit drawn into an air compressor or internal-combustion engine to cause scoring, other troubles are directly traced to such foreign deposits.

A common operating trouble experienced with compressors is "carbon" deposits on the valves, causing them to leak and so lowering the compressor capacity. Chemical analysis of such a deposit reveals that it is made up of 90 per cent dirt and grit and 10 per cent hydro-carbon; the latter is the remnant of the lubricating oil and acts as a binder in holding the dirt.

In oil engines the same trouble is experienced, although the ill results are more important and may even cause shutdown. The deposits are more pronounced on the exhaust valves and, by holding the valves off their seats, cause the engine's compression to be lost. As even a slight decrease in the compression will cause a loss in power of a gas engine or an oil engine, it is obvious that dirt should be kept out of the engine.

This is especially true for an installation where the engine is located in a dusty atmosphere or where the air must be drawn from a building carrying dust, such as cement, flour or rock.

In Fig. 1 is shown how one engine user solved the problem. The engine was a four-stroke-cycle solid-injection Diesel and drew air directly from the engine room which opened into the machine shop. An air filter made up of a series of screens upon which had

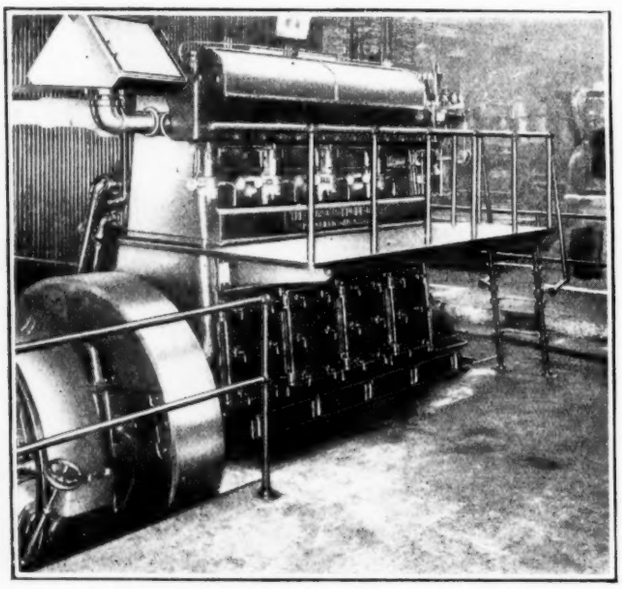


Fig. 1—Filter is placed on air intake of oil engine

been smeared a sticky substance, was placed at the end of the air-suction pipe. The air passing over and through these partitions gives up any dust content.

In two-stroke-cycle Diesels the air for the working cylinders is drawn into the scavenging air pump for compression to 4 or 5 lb. per sq.in. before introduction into the cylinders. Dirty air will score the compressor valves as well as cause carbon formation. In many plants the air intake to the scavenging pump is passed through a filter, as at *A*, Fig. 2. This engine is a 750-hp. Diesel installed in a Texas cotton-seed oil mill. The atmosphere around such mills is always filled with fine particles of fiber and seed meal.

In place of factory-built filters an emergency filter can be made of cloth surrounding a slotted pipe or a

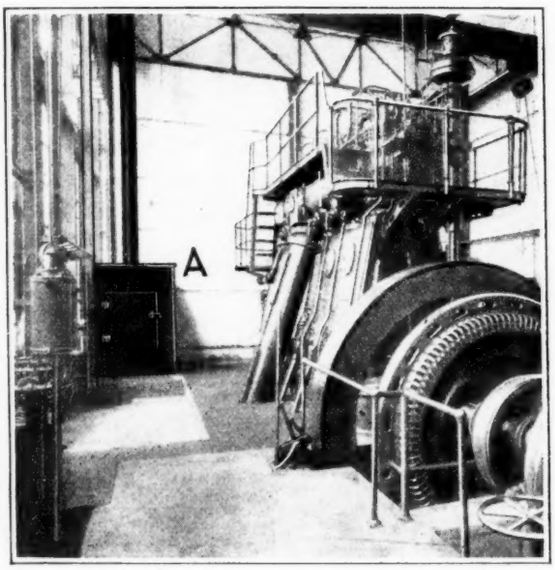


Fig. 2—The air to the scavenging pump of this engine first passes through the filter A

pipe section made of netting placed at the end of the suction pipe. Such a filter is frequently used on air compressors, but its efficiency is not high.

The oil on a splash-lubricated steam engine is subjected to one form of contamination that most other oiling systems do not have to take care of. This is the contamination due to admixture of condensed steam carrying emulsified cylinder oil. When a steam cylinder is properly lubricated, the water leaking through the stuffing box will carry emulsified cylinder oil into the crankcase, particularly if a compounded oil is used. This emulsified cylinder oil and water has a great tendency to emulsify the rest of the engine oil in the system. The high viscosity of the cylinder oil also raises the viscosity of the engine oil, and the increased viscosity, together with the content of emulsified animal oil, causes the engine oil to deteriorate rapidly. A greater load is placed on the cleaning apparatus, and the loss of good oil that has been partly emulsified is increased. Special arrangement of filters and separators is frequently required in order to maintain the oil in a proper condition.

According to tests made by the Bureau of Mines with heating boilers, at low ratings bituminous coal (Pittsburgh lump) and coke were of about equal steaming value; at medium and higher ratings the coals evaporated more water than the coke. The byproduct coke had a steaming value about 90 per cent of that of the bituminous coals at the higher ratings. When coke was burned at a low rating, the over-all efficiency was high—about 76 per cent—but at the higher ratings this efficiency was less than that of the bituminous coals, being about 66 per cent.

Boiler Scale

THE statement is made, upon authority of the president of a well-known boiler-tube cleaner company, that for every pound of scale removed, a saving of two pounds of coal for each ten hours of operation is effected. Whether this is based upon calculations or represents observed conditions we do not know, but at this rate, assuming $5 coal, each pound of scale removed from a boiler, after three months' continuous operation, would represent a dollar wasted.

Undoubtedly, the waste of coal from this cause in many plants is considerable, not to mention the hazard of burned tubes. It is one of those conditions so common to power plant operators that little scientific study has been made of it.

Many factors enter into the problem, such as character of the water, rate of steaming, temperature of the steam and location of the scale, which, of course, is largely determined by the type of boiler. Moreover, the character of the scale itself will have some effect on the rate of heat transfer. Technical literature is replete with reports of studies on heat-insulating materials, aimed at keeping heat in the steam, but authentic data on obstacles to the transfer of heat to the steam are scant. One will find in old handbooks rules for figuring the loss due to various thicknesses of scale, but the sources of such rules are obscure, and it is doubtful if they were based upon scientific investigation. Therefore, might it not be well for some research body to investigate this subject under actual operating conditions?

Knowing Plant Costs

THE success of the small isolated plant in withstanding central-station competition is a twofold problem. The physical possibilities must be well developed, and the actual performance of the plant must be appreciated by its owner.

The physical aspect of the problem is receiving attention from the manufacturers of equipment. For auxiliary service in the large plant or for main units in the small plant there is a growing demand for small steam turbines capable of yielding good economy and designed to receive steam at high pressure and temperature. Equipment is available for the alert operator with which he can build a plant of small capacity whose thermal economy will be altogether creditable in comparison with the large plant.

On the other hand, whatever the performance of the small plant, there is an easy tendency to fail to give full credit for what is really accomplished. In comparison with an up-to-date central station representing an investment of several million dollars, it is easy to assume that the small factory power plant is grossly inefficient. This is not necessarily true. Especially if any appreciable part of the exhaust steam is utilized, the small plant is likely to produce its power at very low cost.

The operating engineer of the small plant should know his costs. He should have his data in such shape that he can readily draw off a comparative statement of costs for running the plant for heat and power and for heat alone. It would be helpful to draw up such a statement at regular periods—by months or by seasons—and lay it before the "big boss." His respect for the operating man will be strengthened, and his knowledge of the power end of the business will be increased. Moreover, should competition arise, the operator will be prepared with facts which he is prepared to back up.

Studies along this line have great educational value for the operator. The analysis of performance for a small plant is the same as for a large one. The man who aspires to a bigger and better job should seize every opportunity to make his present job as big as it can be made.

The Lecture Fetish

THOSE who are in close touch with the problems of the so-called "higher education"—that is, education of university grade—know the serious shortcomings of the lecture as an instrument of education. Lectures have their proper place in the educational scheme, but there has been and still is a tendency to overrate their importance. Some even speak of "attending lectures" at a certain college as if this, in itself, implied getting an education. Nothing could be further from the truth, although a certain superficial acquaintance with the subjects of the curriculum may be acquired in this manner.

In technical and scientific courses particularly, it is rarely worth while to spend more than a third of the classroom time in lectures. This is especially true of such fundamental studies as mathematics, mechanics, physics, chemistry and thermodynamics. Excellent textbooks are available in all these fields. There is no justification for a series of lectures telling nothing that could not be told as well or better in a textbook.

The great advantage of the textbook is that the student can adjust his rate of reading to his capacity for absorption. He can speed up at some points and at others slow down even to the extent of reading one paragraph over several times until it penetrates. No two individuals are alike, and no set lecture can so effectively meet the requirements of a group of assorted individuals. If the textbook is not clear, owing to overcondensation or lack of enough illustrative examples, a new one should be selected or written.

The most serious abuse of the lecture system is found in the "lecture course," particularly as applied to elementary technical or scientific subjects. In almost every college are to be found horrible examples of this method of hypnotizing immature students into the belief that they are thereby becoming educated. Cases have been

known where chemistry has been "taught" in a series of lectures wherein the professor merely droned out the substance of a textbook, the students industriously scratching down his golden words in their notebooks. The final result of this procedure is a second-rate and messy textbook produced with labor that would have purchased many copies of a better book manufactured with the aid of the printing press.

It is not proposed that all set lectures be abolished. In moderation they have their uses. The personality of an inspired teacher, as revealed in his lectures, may instill enthusiasm in the case of subjects like sociology or history, which are much concerned with human nature. Demonstrations with apparatus are valuable in the case of physics or chemistry. But it is contended that dictating textbooks to students is a shameful waste of time.

Experience has proved that the most successful method of teaching engineering subjects involved an enforced and detailed study of proper textbooks followed up by the solution of problems at home by quizzes, laboratory work, computing periods and by recitations consisting of a rapid-fire give and take between professor and students. What others tell us leaves but a thin tracing on our brains. It is what we sweat out for ourselves and apply and express with our own tongues and pens that becomes a permanent part of our intellectual equipment.

Federal and State Rights in Water Power

WHAT has been occurring in Congress during the last month in attempts to suspend all action in water-power developments on the Colorado, Columbia and Tennessee rivers, raises the question as to how far the federal government should be allowed to go in exercising control over navigable streams. Where there are a number of interests, such as navigation and water power on the same river, and where these may involve a number of states, there is no agency in a better position to deal with the project as a whole than the federal government. Although such control may result in temporary economic losses to the states, the final outcome cannot fail to be of the greatest benefit to all interested if the control is intelligently administered.

The individual states have an interest in these projects, in seeing that they are made possible of development with the least delay. Development of these sources of power in many states means industrial expansion, and unnecessary delays may have serious economic consequences. These are the conditions that are found on the Tennessee River. Army engineers have surveyed the rivers for the federal government and proposed a series of developments that will utilize the total head of the river for power and at the same time make it navigable. Now that this has been done, the question naturally arises as to the justification of the federal government's right, legal, moral or otherwise, to try to suspend all development on this river for two years. The government has laid out its proposed program of development and has the power vested in the Water-Power Commission to see that this program is carried out, and the state is anxious to see the work started. Apparently, capital is available to undertake the development of a number of these projects, so that further delay can only result in jeopardizing the interest of the State of Tennessee, with no benefit to the federal government.

The reason for this proposed delay is to give time for Congress to decide what to do with Muscle Shoals. Any development that may be made above the Shoals will benefit it, since it will help to regulate the flow of the river. Furthermore, the control of the flow of the river is vested in the Water Power Commission, and it is a requirement written in every license involving storage, that such storage shall be so handled as to be of common benefit to all plants past which the water runs. In view of these facts it would appear that any further control exercised by the federal government over developments on the Tennessee River or others under the same circumstances, is an unnecessary exercise of federal authority and trangresses the rights of the individual states.

A Power-Plant Tickler

THE suggestion to be made here will be an old story to many engineers, particularly to those who have had office experience, but to others it may come as a new and valuable idea.

The so-called "tickler" is now an established institution in most business offices. Those who use it could hardly carry on their daily work without its aid. In the simplest form it consists of a filing cabinet with a folder for each day in the year. If any matter should be attended to on a certain date a note (with any pertinent papers) is slipped into the proper folder. At the opening of each business day all notes are withdrawn from the tickler folder for that date and given immediate consideration. As far as possible the indicated steps are taken without delay, but matters that cannot or need not be attended to at once may be given new tickler dates and reinserted in the file. No note is ever destroyed until the matter has been cleaned up one way or another.

Such a mechanical memory is as useful in the power plant as anywhere else. It is particularly valuable as a reminder service for the routine inspection and overhauling of equipment.

A good indication of the importance that the general public attaches to power matters, as part of our whole industrial structure, is furnished by the fact that a leading New England newspaper devotes two columns on its first page to a report of the opening of the Power Show in Chicago.

The index for volume 62, the last half of 1925, is now ready and will be mailed free upon application and automatically to those subscribers who have already requested that their names be carried on the permanent mailing list for current and future indexes.

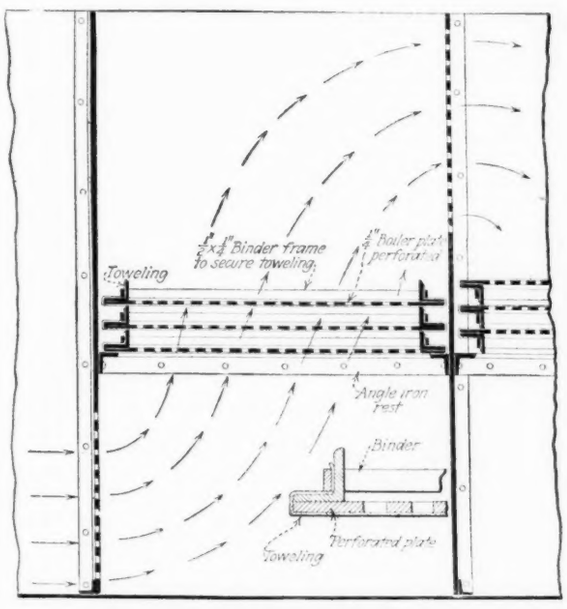
France is becoming a close second to this country with regard to the size of prime movers employed. Forty thousand kilowatt units are already in service and fifty thousand kilowatt units are under construction.

New Yorkers have long been accustomed to boast of the city's sky line. Other topics will soon be in order if the smoke problem is not taken in hand.

Practical Ideas From Practical Men

Removing Oil from the Boiler Feed Water

In our plant we have a multi-screen grease extractor connected in the boiler feed-water line. Also a four compartment feed-water hotwell or filter box. The water delivered by the condensate pump during its passage through the filter-box compartments passes respectively under and over three perforated baffle plates. Each compartment through which the water passes is packed in the conventional manner with various filtering materials, such as excelsior, sponges, burlap bags, etc., to which the oil and grease suspended in the water are supposed to adhere and thus be prevented from entering the boiler. Of course this is effective in trapping most of the oil and grease, as the



Arrangement of cloth-covered plates in filter box

excelsior is changed periodically and the sponges are also taken out and cleaned at intervals. However, this cleaning operation is rather a messy job and is not performed more often than is thought necessary.

In order to eliminate a lot of this bother, we devised a series of filtering cloth covered perforated steel plates, which we arranged horizontally about the middle of the two center compartments of the filter box and which have proved effective for the purpose intended.

As can be seen from the sketch, which shows a section of the center compartments, we first drilled and riveted into each of the two boxes eight 1-in. angle-iron strips, nicely fitted at the corners, to form a rest or support for the plates.

The plates are made of ¼-in. boiler-plate stock, drilled three at a time with ½-in. holes spaced equal distances apart and made to fit loosely in the section so as to be easily dropped into place or removed. In order to provide a rapid means of strapping the filtering cloth over the perforated plate, we attached a sort of binder to each. This consists of two lengths of 1-in. angle iron permanently fastened to the outer edge of the two long sides of the plate, and a binding frame made from ¼x½-in. cold-rolled steel to fit fairly tight between the angle-iron uprights and act as a binder for the filtering cloth stretched over the plate.

The assembled units are laid down three in each compartment, the first one placed cloth side down, resting on the angle-iron frame or support, thus forming a sort of gasket around the edge.

We change the cloth every day, as it requires but a few minutes to do so and has proved a wonderful help in keeping the boilers free from oil.

For filtering cloth we use a cheap grade of toweling and keep several changes on hand, washing and reclaiming one set while the other is in use.

The cost of installing this little filtering device amounts to very little in comparison to the time and labor that would be required to remove this oil should it get into the boiler.

GEORGE W. WOOD.

Brooklyn, N. Y.

How to Reduce the Percentage of Scrap in the Power Plant by Autogenous Welding

At the outset it should be mentioned that autogenous welding possesses specific advantages not equalled by any other process applicable to power-plant engineering. The scope of autogenous welding processes are wide, and their possibilities have not yet been realized and exploited in power plants to the fullest extent. In connection with the maintenance of our plant, the repair of boilers, compressors, pumps, gear wheels, tanks, pipes, valves, fans, etc., are undertaken by the oxyacetylene welding crew. In many cases parts of machines that would otherwise go to the scrap heap are repaired by the welding process and put back into service in a comparatively short time.

In repairing broken gear teeth, for instance, our method is to insert a carbon block at each side of the teeth to be repaired and fill up the spaces with molten metal. To insure the knitting of the teeth to the rim, the torch flame is directed into the cavity until the rim metal fuses a little, after which the welding rod previously dipped in ferro-flux fills in, leaving a little surplus metal to be dressed off the top.

Preheating is employed on cast-iron gears, when the face is over 3 in. wide and the rim more than 1 in. thick; first, because it effects a saving in acetylene and oxygen, and secondly, because it is a means of compensating for the expansion and contraction produced by the heat of the torch flame. After the welding is finished, the gear should be buried in hydrated lime in an annealing box or covered with powdered asbestos. Large castings can be efficiently annealed in a charcoal fire and allowed to cool slowly.

The carbon-block method described herein, is not always desirable as in cases where a broken gear has cut teeth and a gear cutter is available; here the preferable practice is to build in the broken teeth and adjacent tooth spaces solid with new metal and then cut two spaces on the gear cutter. This method invariably produces a solid, well-formed tooth.

Ruptured or broken pipes are frequently repaired by oxyacetylene welding. When the break is a longitudinal rupture, as is usually the case, it is repaired by first cutting away the ruptured and weakened metal, leaving a rectangular opening in the pipe. A rectangular patch of the same thickness and curvature is then obtained by cutting it from a scrap length of the same diameter and class of pipe. Should the metal be ¼ in. or more in thickness, the edges of the pipe opening and patch should be beveled to 45 deg. so that when the patch is inserted in position a 90-deg. angle will be formed. The patch must be arranged and secured so that during the welding operation it remains firmly in position.

The welding operator should bear in mind that any repair job to be welded in the power plant, must be properly prepared, cleaned, lined up, etc., before the torch is applied. In welding steel, oxidation is the most serious defect and it must be reduced to a minimum by using first-class torches, well regulated and properly handled. A welding rod especially manufactured for welding steel should be used. Joints on cast-iron pipes and repairs to cast-iron products are most satisfactorily effected by bronze welding.

In conclusion, it might be stated that in many cases the actual cost of doing a welding repair job is not the most important feature. Generally, it is the time element that counts in power plants, especially where the replacement of a part would necessitate a long delay for the delivery of new castings. E. ANDREWS.

Manchester, England.

How the Over-all Efficiency of the Steam Plant Was Increased

Many engineers labor under the impression that in order to increase the over-all efficiency of a plant it is necessary to have a lot of costly instruments and to make radical changes. An engineer will often defend the poor performance of his plant with the statement that the boss will not spend any money on that department, and assumes that he can do nothing in the way of improvement under these conditions. Of course a better showing can be made with the proper instruments than without them, and in older plants changes are often advisable even if they cost several thousand dollars, but a good engineer will find ways to improve operation and reduce costs to some extent without waiting for the owner to spend money in advance.

An engineer in this locality took charge of an old plant and started in at once to save fuel, as he was not content just to keep the plant running, as is often the case. Blotting paper was the product manufactured, and this industry uses a large amount of steam in manufacturing processes as well as for power production. Individual steam engines were used to drive the paper machines, while the rest of the power requirements were supplied by a compound condensing engine. The required pressure on the drier was 30 lb., and any drop in pressure would not be tolerated. The driers were supplied with exhaust steam from the machine-room engines and also with live steam supplied through a reducing valve as required. The engineer wished to reduce the consumption of live steam as far as possible and devoted his attention to this problem. He considered bleeding the receiver of the condensing engine, but quickly discarded the idea, as he found by actual test that 8 lb. was the most economical receiver pressure to carry and 30 lb. was required on the driers. The exhaust of the auxiliaries was used to heat the feed water in an open heater to 212 deg., and the excess went to the atmosphere.

After thinking over the problem, he hit upon this idea: The exhaust from the auxiliaries could be turned into the driers at the desired pressure without interfering with the operation, and the heater could be supplied with steam bled from the receiver at 8 lb. pressure. This plan was considered practical for the following reason: Only the exhaust of the paper-machine engines and about 90 per cent of the auxiliary exhaust was being used in process work, and under the new plan the machine engine exhaust, all the auxiliary exhaust and over 2,000 lb. an hour of the main engine exhaust could be used. The auxiliary exhaust was connected to the machine room, requiring a run of 38 ft. of 4-in. pipe, and only a few feet of 3-in. pipe was required to make the connection between the engine and the heater. Much of this work was done with the same pipe and fittings then being used, so very little material had to be purchased. He estimated a saving of 1,000 lb. of steam an hour, and this was realized in practice. The cost of operating the auxiliaries did not increase with the increased back pressure, since all the exhaust was used. With about 2,000 lb. of steam bled from the receiver, 900 lb. additional was admitted to the high-pressure cylinder, making the net reduction in main engine steam flow over 1,000 lb. an hour.

There were two water-service pumps in the mill, one a triplex plunger pump used constantly, driven from the mainshaft, and a reserve steam-driven pump. As there was still a deficiency of exhaust in the driers, the engineer decided to reverse the method of using these pumps. He gave orders to run the steam pump all the time and threw the belt off the triplex, leaving that as the reserve unit. This had the effect of increasing the exhaust-steam supply and reducing the main-engine steam consumption still further. To determine what this reduction was, he took indicator cards and found a difference of 15 hp. existed when changing over from the triplex to the steam pump. Giving the engine an arbitrary steam rate of 14 lb. per hp.-hr., this change saved over 200 lb. of steam an hour. This saved nearly 100 tons of coal annually.

The most economical distribution of load between the high- and low-pressure cylinders of the engine was found by a little experimenting. Contrary to the usual idea the economical point was not with an equal division of load between cylinders even before any attempt was made to bleed the receiver. The high-pressure cylinder, taking steam at 130 lb. and exhausting at 8 lb. into the receiver, developed 56 per cent of the total power output, and any variation from the receiver pressure caused the governor to revolve in a lower plane, indicating later cutoff and increased steam consumption. The net result of all this study was a reduction of about $5,000 a year in operating costs without any expense being incurred in the undertaking.

Brightwood, Mass. ANDREW F. SHEEHAN.

Comments from Readers

Boiler Furnace Temperatures with Preheated Air

There has been much speculation relative to the effect of preheated air on furnace efficiency and maintenance.

The reports of the Congrés du Chauffage Industriel 1923 and Prime Movers Committee 1925 point out that there is sufficient information available to make definite predictions as to heat recovery and draft loss with air heaters, although it will probably be several years before worth-while maintenance information will be obtained.

It is comparatively recent that it has been possible to solve the theoretical question of furnace temperatures. These practical data are not as yet generally known, which explains why the practical application has been promulgated so slowly.

The problem becomes comparatively simple if we start with cold fuel and cold air. The maximum temperature that can be obtained by the combustion is simply that temperature to which the heat generated can raise the products of combustion. For example, one pound of Pittsburgh coal having a heat value of 13,870 B.t.u. dry when burned with 129 cu.ft. or 10.4 lb. of air at 32 deg. F. dry will raise the products of combustion to 3,768 deg. F.

If the air is preheated, the sensible heat is added to the heat generated by the combustion to give the total amount of heat that must be present in the products of combustion. In this connection it is practical to use 0.24 for the specific heat of air for temperatures between 320 and 500 deg. F.

If we assume that the air is preheated 300 deg. F. the heat recuperated is $300 \times 0.24 \times 10.4 = 748.8$ B.t.u. Adding this to the heat of fuel 13,870 B.t.u. gives a total of 14,618 B.t.u. brought to the furnace by the fuel and air for each pound of coal burned and will increase the theoretical temperature to 3,936 deg. F. or an increase of 168 deg. F.

During the Congrés du Chauffage Industriel 1923, a manufacturer of air heaters stated that the elevation in furnace temperature was seven-tenths of the preheated air. This point was discussed and shown to be in excess of that which could possibly occur and the theoretical calculation indicated that with Pittsburgh coal the increase was about 56 per cent.

Such calculations are long and complex, making it desirable to use a curve based on the same data for making computations; for example, we will determine the furnace temperature of a boiler in which 14.5 lb. of coal is burned per square foot of boiler tube projected area exposed to the fire or, say, approximately 200,000 B.t.u. released per hour at 15.2, 14.1, and 13 per cent CO_2, the combustion air being preheated 300 deg. F. The heat brought to the furnace by the preheated air, per pound of coal, will be as follows: At 15.2 per cent CO_2, $12.48 \times 300 \times 0.24 = 898.56$ B.t.u., or 6.5 per cent, at 14.1 per cent CO_2, 973.44 B.t.u., or 7.1 per cent, and at 13 per cent CO_2, 1,048.32 B.t.u., or 7.6 per cent.

The heat recovered, 6.5, 7.1 and 7.6 per cent brought to the furnace with the fuel and air without increasing

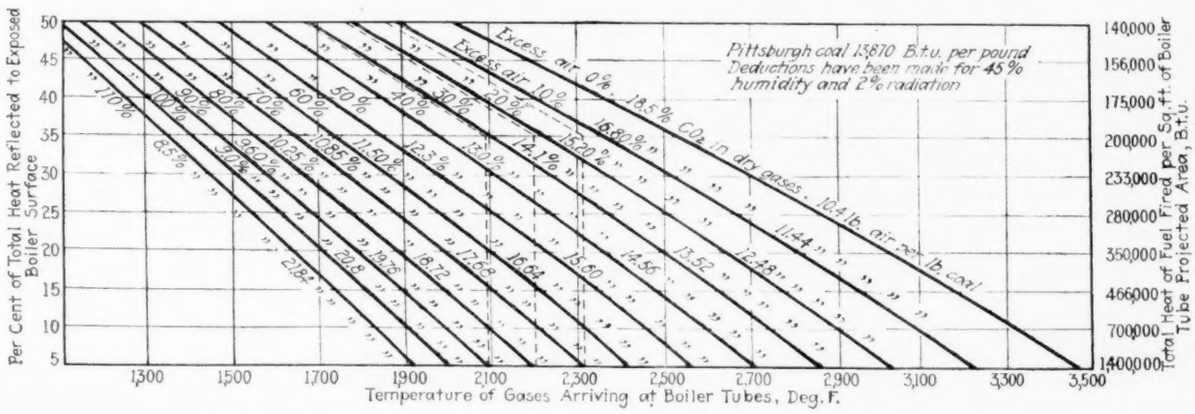

Pittsburgh coal 13870 B.t.u. per pound
Deductions have been made for 45% humidity and 2% radiation
Excess air 0% 18.5% CO2 in dry gases 10.4 lb. air per lb. coal
Excess air 10% 16.80% " " " " 11.44 " " " "
Excess air 20% 15.20% " " " " 12.48 " " " "
Excess air 30% 14.1% " " " " 13.52 " " " "
Excess air 40% 12.3% " " " " 14.56 " " " "
Excess air 50% 11.50% " " " " 15.60 " " " "
Excess air 60% 10.85% " " " " 16.64 " " " "
Excess air 70% 10.25% " " " " 17.68 " " " "
Excess air 80% 9.60% " " " " 18.72 " " " "
Excess air 90% 9.06% " " " " 19.76 " " " "
Excess air 100% 8.5% " " " " 20.8 " " " "
Excess air 110% 21.84 " " " " " " " "
Per Cent of Total Heat Reflected to Exposed Boiler Surface
Total Heat of Fuel Fired per Sq.ft. of Boiler Tube Projected Area, B.t.u.
Temperature of Gases Arriving at Boiler Tubes, Deg. F.

Chart for determining temperature of gases arriving at boiler tubes

the weight, greatly increases the temperature of the gases.

The rise in temperature is equivalent to burning a quantity of coal having the total heat value of that brought by the coal and air, but the quantity of air is not increased, therefore the effect is the same as burning the coal with less excess air, the amount of excess air being determined as follows:

At 15.2 per cent CO_2, $\frac{13,870}{13,870 + 898.56} \times 1.20 = 1.13$, or 13 per cent excess air. At 14.1 per cent CO_2, $\frac{13,870}{13,870 + 973} \times 1.30 = 1.21$ or 21 per cent excess air, and at 13 per cent CO_2, $\frac{13,870}{13,870 + 1,048.3} \times 1.40 = 1.305$, or 30.5 per cent excess air.

To find the corresponding temperatures we lay in curves on the chart for 13 per cent, 21 per cent and 30.5 per cent excess air as indicated by the dotted lines, cutting the horizontal line 200,000 B.t.u. and by draw-

ing vertical lines to the bottom, we read the temperatures. With 15.2 per cent CO_2 or 20 per cent excess air, average temperatures in the furnace with cold air is 2,203 deg. F., and with preheated air 2,310 deg. F. With 14.1 per cent CO_2 or 30 per cent excess air, average temperatures in the furnace with cold air is 2,097 deg. and with preheated air 2,205 deg. and with 13 per cent CO_2 or 40 per cent excess air, the average temperature in the furnace with cold air is 1,980 deg. and with preheated air 2,095 deg.

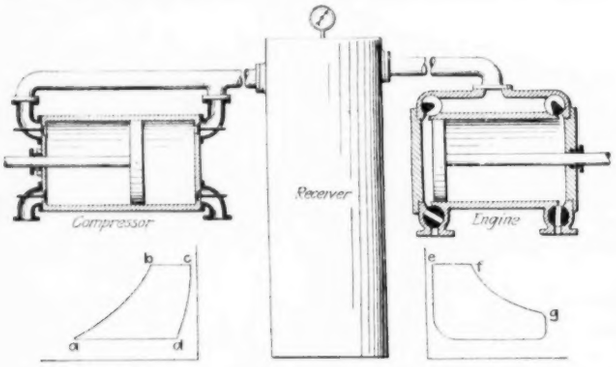
This method of determining furnace temperatures is both theoretically and practically correct and should be helpful to those considering the use of air heaters, as serious consideration should be given to the amount of boiler-tube surface exposed to the fire. This surface should be increased when preheated air is used if it is desired to maintain the same maximum boiler evaporation or rating, otherwise it will be necessary to reduce the boiler capacity.

J. GOULD COUTANT.

New York City.

Terms Total Heat and Heat Content Unsuitable

It is gratifying to note that under the title, "Steam Table Research," in the Dec. 8, 1925, issue, the suitability of the terms "total heat" and "heat content" has been challenged and that definite action has been



Compressor and engine connected to same receiver with typical diagrams

taken by the A.S.M.E. to develop a more comprehensive name for this important thermal property of substances. The article, "What Does a Pound of Steam Contain," published in the Nov. 24, 1925, issue, was intended to clarify the matter so far as it relates to vapors. These terms are more especially unsatisfactory and disconcerting when applied to gases.

Referring to the illustration, gas is delivered by the compressor to a receiver at substantially constant pressure. This process is represented by the line *bc* on the *PV*-diagram for the compressor. Owing to the capacity of the receiver and the double action of the compressor, the pressure of the gas in the supply line is not materially lowered during the period of admission to the engine. Thus the admission line *ef* on the *PV*-diagram for the engine corresponds to a constant-pressure condition, such as might obtain if the discharge from the compressor occurred simultaneously with admission to the engine.

Considering the matter from this latter point of view, it will be apparent that during admission to the engine the gas acts merely as a transmission device, much the same as a belt or a lineshaft, to transfer mechanical energy from the compressor to the engine. This "external energy," as it might well be called, is analogous to the "external latent heat" of a vapor and is available only in a contant-pressure process. In an engine of the expansion type, the inlet valve would close at the point *f*, thus shutting off communication with the source of supply, and the subsequent expansion of the gas, represented by the line *fg*, would convert intrinsic energy into mechanical energy.

The outstanding difference between the external energy of a gas and the external energy of a vapor is in the origin of this energy. The external energy of a vapor, commonly called "external latent heat," is due to the increase of volume accompanying vaporization of the liquid at constant pressure, which is the direct result of applying heat to the substance. In this case the use of the term "external latent heat" is pardonable. In the case of a gas, however, external energy is made available, not by the application of heat to the gas, but rather by the direct application of mechanical work at the compressor. Thus it is an ambiguity to speak of "external latent heat" and "total heat" in reference to the energy of a gas.

The unanimous vote of the A. S. M. E. representatives for some definite action in favor of a change of nomenclature undoubtedly bespeaks the opinion of the engineering profession at large.

L. A. WILSON, Associate Professor,
Madison, Wis. University of Wisconsin.

Purchase of Coal on Specification

Mr. Colburn's article on "The Purchase of Coal on Specification," in *Power* for Dec. 15, 1925, is interesting, but rather misses the present attitude of many large consumers on the subject, "Can it be made to pay?"

Since the War, particularly, there has been too much of a tendency to adjust facts to economic theories rather than fit the theories to the facts. The following paragraph from Mr. Colburn's paper is a fine example of this:

> Purchasing by specification will insure a supply of coal of uniform grade and suitability for the purpose required and afford a means of adjusting the coal bill to the value of the product received. It is hard to understand why, in the coal industry, this process should have been so stubbornly fought and so widely disregarded since it is a basic law of the industry that the value of any product varies in proportion to its usability or utility.

Nearly every form of specification has been tried at one time or another, and no one of them has proved so conspicuously successful as to come into general use, perhaps for the very reason, the coal man would urge, that the price of coal is fixed not by the value of the product he furnishes, but by what his necessities in a greatly overdeveloped and highly competitive industry compel him to accept. The usual purchaser on specification seems to expect the producer to make him as low a price on his premium-and-penalty contract as he would on the usual form of coal contract (which is little more than a schedule of shipments with a sliding-scale price based on the labor rate) and assume all the risks of loss and extra expense as a favor in return for being awarded the contract.

The aversion of coal operators to specifications is the most natural thing in the world. Even supposing that they get the contract at a price that promises to

break even on correctly determined premiums and penalties, as will be explained in a minute, the penalties can and are likely to be much larger than the premiums, and there are too many other uncertainties which may take away all the profit if not cause an actual loss.

The first of these is the sampling, for without an accurate and representative sample an analysis does not mean anything. The Bureau of Mines has covered this subject so thoroughly that it need only be mentioned that to take and work down the 1,200- to 2,000-lb. sample they recommend for lumpy run-of-mine coal is a healthy day's work for a man, and the man who will do this intelligently and conscientiously can get a whole lot better pay than most firms will allow for coal sampling. The result is that a great deal of this work is let out to commercial laboratories which take the business at a price they think the coal purchaser will be willing to pay, and in consequence have a man take ten to twenty samples per day, none of which means anything except possibly a penalty to the coal operator. Usually, by the time the analysis is made and the penalty reported, the coal is burned up and there is no chance for a check analysis and no redress for the seller.

The reason why incorrect samples run heavily against the seller is that the ash in coal as shown by analysis comes from two sources: The intrinsic ash, that is the mineral matter practically uniformly distributed through the coal, consisting of the mineral substances originally contained in the vegetation that went to form the coal and what has been deposited there by water working down through the earth; and the free ash, that is the slate, bone, clay, etc., which get into the coal from roof, floor and partings in the course of mining. Depending on local conditions and the care in mining and preparation, the intrinsic ash will probably be 60 to 90 per cent of the ash in the guaranteed analysis, so that, if the guaranteed ash is 8 per cent, with the usual 1 per cent margin either way without bonus or penalty, and the intrinsic ash is only 60 per cent of the total, the best premium the operator can get if all the loose slate is picked out is 8 per cent — 1 per cent — (60 per cent of 8 per cent) = 2.2 per cent of ash bonus. But, if in one of those 20-lb. samples there happens to be a 1-lb. chunk of slate more than the average—and it does not take a very big chunk to weigh a pound—the operator is up against a 4 per cent ash penalty. This is by no means an extreme case. So it will be seen that careless sampling makes the odds heavily against the coal seller.

It seems an unfortunate trait of human nature that where a contract provides for an adjustment of price there is always a tendency on the part of the purchaser to push for additional concessions on the basis of some fault in the merchandise not specifically covered in the contract. The time and worry of discussing these points, together with the expense of sending someone occasionally to watch a sample taken or of having check analyses made, introduce such an element of uncertainty into the cost of doing business as to make coal operators avoid such contracts whenever possible.

Mr. Colburn may be right in saying that the practice of contracting for shipments from a single mine has worked badly in some cases owing to a change in the character of the coal as mining developed, but there are a great many other cases where it had worked satisfactorily, and it seems very doubtful whether a screening test could be defined and executed accurately and consistently enough to count for more than would an informal protest on excessive slack by the purchaser.

Mr. Colburn's remarks on the comparative unimportance of moisture, which has no heating value at all, and insistence on the reduction of heating value by sulphur, which generates 4,050 B.t.u. per lb., seem unreasonable, but this aspect of both may be neglected if the heating value of the coal is specified, as it will cover deficiencies due to excessive water or sulphur.

One important reason for watching moisture is to see that a special moisture sample is taken and the analysis of the coal corrected to it for delivered B.t.u. value, for with the exposure of the coal sample to air in cracking down and mixing, 2 or 3 per cent of moisture may be lost and the laboratory sample may be practically air-dry coal.

Ash should be penalized if plant facilities are such that it is expensive to dispose of. The fusing temperature of ash has a more definite relation to the trouble from clinkering than the percentage of sulphur. Another feature to be covered if coal is to be bought on specification outright is the coking quality, which varies greatly in different fields and in different seams.

But the general impression gained from Mr. Colburn's article is that the specification is to apply to the coal from an approved mine, in which case he is putting the operator up against a pretty stiff proposition, for it must be remembered that the bituminous-coal mining industry is not a manufacturing proposition with a standardized product, but just a material-handling proposition on a large scale. Any proposed changes that would interrupt or slow up the passage of the coal from its position in the coal seam underground to the railroad car for shipment, or would make the price received for the coal uncertain, would increase the cost of doing business and with it the price of the coal bought on specification, by an amount altogether out of proportion to the benefits derived.

H. D. FISHER.

New Haven, Conn.

Dressing for Leather Belts

In answer to Mr. Schaphorst's criticism, in the Dec. 29, 1925, issue, of my assertion that neatsfoot oil is recommended as a dressing for leather belts, I may not have made myself clear.

There is a certain amount of natural lubricant in a belt. When after heavy service this becomes exhausted, it is necessary to replace it with a dressing, and experience has proved that neatsfoot oil is a near approach to the natural oil. I do not mean that a belt has to be saturated with it to the extent that it stretches out of proportion or sufficient to rot the fibers. There is a difference between applying a dressing properly and the drastic way he infers it should be put on. A small quantity, carefully applied and the excess wiped off, is ample. Judgment must be used as to how often to apply it.

Mr. Schaphorst recommends a high-grade dressing that does not contain harmful ingredients. I happen to be in a position to know that neatsfoot oil is the base of many of the best-grade dressings on the market. However, although I have used neatsfoot oil with good success, I would be interested to learn the ingredients of the dressing Mr. Schaphorst has in mind.

Hollywood, Calif. MAURICE C. COCKSHOTT.

Questions and Answers

Conducted by

Franklin Van Winkle

Number of Phases in a Wound Rotor for a Polyphase Induction Motor

Why is it that the rotors of wound-rotor induction motors are always wound for three phase and not for the same number of phases as the stator? *H. J. P.*

It has been found that increasing the number of phases in the rotor windings of a wound-rotor induction motor improves the motor's characteristics, particularly at starting. The three-phase winding has been adopted as it requires one more slip ring only than for a single-phase winding and the performance is much better than a two-phase winding. The improvement in performance obtained by going to a greater number of phases than three, does not justify the additional complication. These complications are not only in the motor's winding, but also enter into the control equipment and the starting resistance.

Controlling Speed of Hydraulic Elevators

How is the car speed of hydraulic elevators regulated? *M. E. W.*

On the horizontal type two methods are used: First, by increasing or decreasing the length of travel of the controlling valve; second, by opening or restricting the perforations through the valve sleeve. The latter plan is the better in most instances. By shortening the travel of the main valve, the speed of the car may be decreased, but since shortening the travel does not necessarily influence the speed of the valve travel, this method of stopping the car may be too abrupt. The opening or restricting of the perforations in the valve sleeve controls the volume of water flowing from and to the cylinder without influencing the speed of the valve travel, and more satisfactory starts and stops are possible when the machine speed is governed by adjustment of the valve sleeve. On other types the speed is limited either by pilot-valve travel regulation or by governing valves in the circulating pipe.

Grounding of Windings on the Rotor of Induction Motors

Is the winding on the rotor of a polyphase induction motor grounded to the core, so that a light will be obtained on a test lamp connected between the winding and shaft? *V. K. S.*

In most all modern polyphase induction motors the rotor winding is grounded to the core. It used to be the general practice to insulate the bars of squirrel-cage windings in the slots. In some modern designs of this type of motor the squirrel-cage winding is cast in one piece; in others the bars are driven into the slots and the end rings are cast on, or the end rings are welded to the bars. Any of these constructions preclude the use of insulation in the slots. Squirrel-cage motors tested with and without insulations on the rotor winding show practically no difference in their operating characteristics. On wound-rotor motors the winding should be completely insulated in the slots for the most satisfactory operation of the machine. In some cases one of the rotor winding leads to the rings is grounded to the core and the ring to which this lead would be connected is pressed on the shaft without insulation, so that there are only two insulated leads and rings.

Dielectric Strength and Insulation Resistance

What is the difference between dielectric strength and insulation resistance of a non-conductor of electricity? *M. W.*

All insulating materials are known as dielectrics. None of the so-called insulators completely prevents the flow of electric current. There is always an electric current flowing between any two conductors subjected to voltage. This current on a well-insulated circuit is very small, amounting to such quantities as one millionth of an ampere. The value of the current flowing through the insulation varies as the voltage and inversely as the resistance of the insulation. The resistance offered to the flow of an electric current is known as the insulation resistance. For example, if 250 volts, when applied between the shaft and commutator of a motor's armature, causes a current of 0.00005 ampere to flow through the insulation, the insulation resistance will be equal to $250 \div 0.00005 = 5{,}000{,}000$ ohms, or 5 megohms.

The insulation resistance of a circuit is no measure of the voltage required to cause an actual break-down or puncture of the insulation. A circuit or device may show a high insulation resistance and yet the insulation break-down at a comparatively low voltage. It is the ability of an insulation to withstand the application of voltage that determines its dielectric strength. It is necessary that these measurements be made under some specified conditions to have any meaning. For example, the dielectric strength of transformer oil is generally measured by immersing two round metal disks, one inch in diameter, separated 0.1 in. in a sample of the oil. If it requires only 18,000 volts to cause a failure of the oil between the disks, the dielectric strength of the oil would be shown to be low and should be put through a purifier to restore its dielectric qualities. On the other hand, if it required 26,000 volts to cause a flash through the oil between the disks, the dielectric strength of the oil would be considered high and its conditions satisfactory.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

Energy

WHILE much is heard about the immense stores of energy locked up within the atoms, the engineer of today is more immediately interested in those stores of energy due to attractions between molecules and between different kinds of atoms.

The energy in coal resides chiefly in the attraction that atoms of carbon have for atoms of oxygen in the surrounding atmosphere. It is as though each atom of carbon were connected to two of oxygen by long rubber bands, awaiting only a certain trigger action (known as ignition) to allow them to jump together and form the familiar carbon-dioxide molecule.

In the act of coming together the atoms give up the energy represented by their original attractions — the "stretched rubber bands." This is passed on to the molecules, which in turn display their new-found energy in the war dance which the human observer calls sensible heat. Crudely stated, the collision of the atoms makes the molecules hot. A "hot" molecule is merely one that is moving with unusual speed and is therefore capable, by collision, of speeding up the motion of some other molecule.

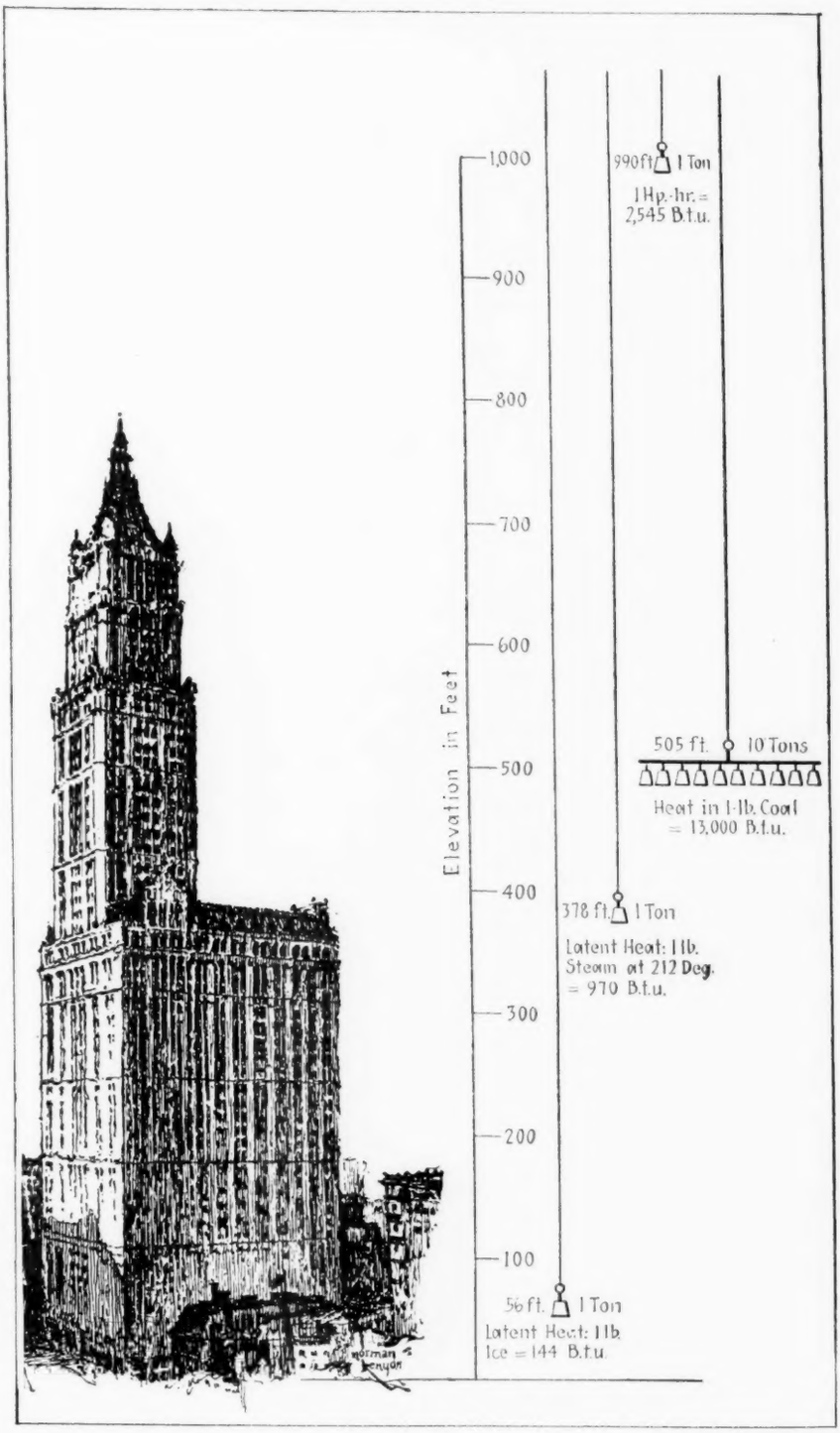
The rapidly moving molecules of carbon dioxide soon collide with everything in sight, sharing their speed, or heat, with the adjacent molecules of nitrogen and unburned oxygen, so that the whole mass of combustion products becomes uniformly heated. When these rapidly moving gas molecules meet the iron molecules of the boiler tubes, they impart to them increased movements which are passed on through the walls of the tube by successive collisions to the water within. The added speed enables water molecules to escape in great numbers as steam from the attraction of their associates in the liquid.

The steam thus formed contains latent heat in the form of attractions between its molecules and is ready at any time to pass it on to condenser tubes or other cold surfaces.

Expressed in terms of lifted weights, the energy required merely to vaporize a pound of water is surprisingly large. It would raise a ton 378 ft. This is figured as follows: To vaporize one pound of water "from and at 212 deg." takes 970 B.t.u. Since each B.t.u. is equivalent to 778 ft.-lb., this equals 970 × 778 = 755,000 ft.-lb., which, divided by 2,000 lb., is 378 ft.-tons, the energy required to raise one ton vertically 378 ft.

In the same way the 144 B.t.u. given up by one pound of ice in melting would lift one ton 56 ft. A horsepower-hour (2,545 B.t.u.) would lift a ton 990 ft., while the 13,000 B.t.u. in a pound of average coal would raise a ton 5,050 ft. (nearly a mile) or raise ten tons 505 ft.

In order that the reader may better picture these heights, they are shown to scale in the accompanying sketch, alongside the 792-ft.-high Woolworth Building—the world's tallest inhabited structure. For the sake of visibility it has been necessary to draw the ton weights about 15 ft. thick.



Woolworth Building compared with heights to which various quantities of energy would raise ton or ten-ton weights

Boiler-Water Conditioning with Special Reference to High Operating Pressure and Corrosion*

By Dr. R. E. Hall†

WHEN the criterion for control of scale prevention on the evaporating surfaces is made the conditions in the concentrated boiler water, then this control becomes an exact operation amenable to an accuracy commensurate with all other operations in the boiler room. The responsibility in boiler-water conditioning, however, includes more than clean surfaces. Corrosion in feed lines, economizers and the boiler is a function of the condition of the water and must be controlled. Steam-line and turbine-blading deposits must be obviated by the system of conditioning. By the chemical treatment employed, the amount and character of non-condensable gases in the steam must be controlled in accordance with the intended use of the steam.

All in all, the responsibility in boiler-water conditioning ends not with the entrance of the water into the boiler, but with the passage from the boiler nozzle of steam, the dryness and purity of which are defined by the uses to be made thereof.

A clearer conception of the scope of boiler-water conditioning can be obtained by reference to a diagram of the surfaces at which it functions. Consideration of such a diagram leads to the following outline for the problems of boiler water conditioning:

(a) Prevention of scale formation on surfaces.
  (1) In contact with water but at which no evaporation occurs.
  (2) At which evaporation is occurring.

(b) Prevention of corrosion on surfaces (1) and (2) of (a).

(c) Selection of chemical treatment on the basis of non-condensable gases that are permissible in the steam.

(d) The control of sludges and soluble salts in the boiler water.

(e) The removal of entrained moisture from the steam.

Prevention of Scale Formation on Evaporating Surfaces

The following expression serves as a general criterion for the elimination of scale formation on the evaporating surfaces:

Concentration in the boiler water of chemical used in treatment = *Function of (a) the operating pressure, (b) concentration of sulphate (SO_4) in the boiler water.*

This expression makes no limitations regarding the type of feed water to be used or as to the methods of conditioning that will be employed. It makes no specifications whatever regarding the methods that will be used for removing any sludges produced. It is a generalized statement of the fact that the two major factors to be considered in prevention of scale formation on the evaporating surfaces are operating pressure and the sulphate concentration in the boiler water. Two principles governing adherent scale formation on the evaporating surfaces must be recognized in order to define the term, chemical used in treatment.

1. The adherent scales which grow in thickness are formed by deposition from the boiler water directly on the surfaces where found when the boiler is opened. This may be called deposition *in situ*. There are three substances that deposit from the boiler water in this manner, namely, calcium sulphate, calcium silicate and magnesium silicate.

2. The solubility of substances that form adherent scales decreases with temperature increase; vice versa, those substances that separate from the boiler water as sludge increase in solubility with temperature increase.

Therefore, the chemical used in the final conditioning of the boiler water must be one that if maintained at the concentration defined by the operating pressure and the amount of sulphate present in the boiler water, prevents the formation of any calcium sulphate or calcium and magnesium silicate at the evaporating surfaces, and insures the separation of sludge-forming substances only.

This discussion has to do only with the final conditioning of the boiler water, and consideration will be given to but two substances that meet the requirements noted herein, namely, sodium carbonate (Na_2CO_3, soda ash) and sodium phosphate (Na_3PO_4). Sodium carbonate and phosphate have been specified because they can be purchased in the market more cheaply than other carbonates or phosphates. It must be recognized, however, that they are used because of their available carbonate (CO_3) and phosphate (PO_4) content, and that other than their sodium compounds, as for example their potassium compounds, might be used if they were cheaper or if a special reason existed for their use, as for instance, in the use of barium carbonate ($BaCO_3$).

Regardless of any pretreatment that may have been given to the feed water, the essential relation to maintain in the boiler water is expressed thus when soda ash is used for the purpose:

$$CO_3 = K_1 \text{ (at operating pressure } p) \times SO_4$$

If sodium phosphate is used, then the expression becomes

$$PO_4 = K_2 \text{ (at operating pressure } p) \times SO_4^{\frac{2}{3}} \times D^{\frac{1}{3}} (SO_4)$$

In these expressions CO_3, PO_4 and SO_4 (sulphate) are preferably measured in parts per million, though grains per gallon may be used as well. K_1 and K_2 are specific constants for CO_3 and PO_4 respectively, and are constants for a definite operating pressure p, but vary with variations of the operating pressure. D refers to the relation of ionic SO_4 to total SO_4 in the boiler water and is a function of the operating pressure and of concentration of SO_4. As an example of the application of these criteria, at the operating pressure of 150 lb. gage

$$K_1 = 0.0883$$

Thus if the sulphate concentration in the boiler water is 1,000 p.p.m.[1], the concentration of CO_3 therein must be slightly more than 88 p.p.m., etc.

For the use of phosphates at this operating pressure

$$K_2 = 0.000164$$

when concentrations are expressed as parts per million.

For a concentration of 1,000 p.p.m. of SO_4, $D = 0.65$; for 2,000 p.p.m. of SO_4, $D = 0.59$. Substituting these values in the general equation for the use of phosphate, we find that for a concentration of 1,000 p.p.m. of SO_4 in the boiler water, the essential concentration of PO_4 necessary to prevent adherent scale formation is slightly more than 4 p.p.m. and for 2,000 p.pm. of SO_4 slightly more than 11 p.p.m. Simple types of apparatus are described for the determination of SO_4, PO_4 and CO_3 in the boiler room.

The Relation Between Chemical Used and Operating Pressure

It is evident from the expression

$$CO_3 = K_1 \text{ (at operating pressure } p) \times SO_4$$

that the maintenance of scale-free conditions depends upon keeping a definite supply of CO_3 in the boiler water. At boiler temperatures, however, soda ash decomposes according to the reaction

$$Na_2CO_3 + H_2O = 2\,NaOH + CO_2$$

and the rate of its decomposition depends upon the operating pressure and the rating at which the boiler is operated. These two, therefore, in conjunction with the concentration of SO_4 in the raw makeup water, and blowdown practice are the elements which control the feasibility or infeasibility of maintaining the necessary CO_3 concentration.

Thus higher operating pressures are characterized by more rapid decomposition of CO_3; and at the same time by the necessity for maintaining higher CO_3 concentration, since the value of K_1 is greater at higher than at lower operating pressures. In a boiler operating at low rating, it may be possible to maintain the necessary amount of CO_3 in the boiler water while in the same boiler at high rating, the more rapid decomposition of CO_3 may render

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†Physical chemist, Bureau of Mines.

[1] "P.p.m." means "parts per million."

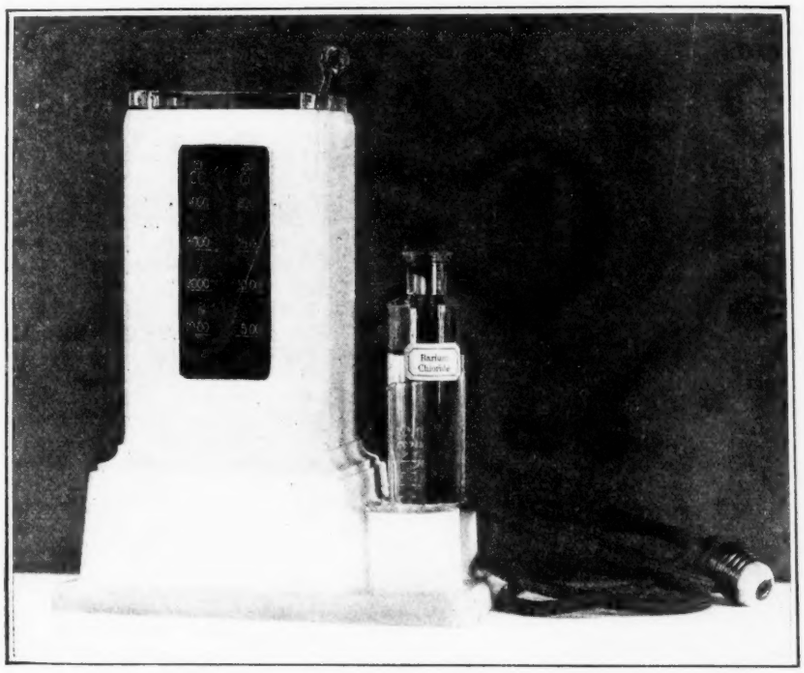


Fig. 1—Front view of sulphate concentration gage

A small sample (10 to 100 c.c.) of filtered boiler water is placed in the rectangular glass jar. The addition of 10 c.c. of acidified barium chloride precipitates the sulphate as a finely divided white cloud of barium sulphate. A slit in the back of the jar is illuminated by an electric light. Seen through the fog of precipitate its outline is fuzzy. Pure water is added until the slit becomes distinctly outlined. By means of scales etched on the jar the corresponding water level indicates directly the boiler water sulphate in parts per million, and serves as a guide to treatment.

such maintenance impractical unless blowdown of uneconomical proportions is resorted to.

The basic cause for these troublesome limitations in the use of soda ash lies wholly in its decomposition into caustic soda and carbon dioxide. Also, apart from the uncertainty from maintaining satisfactory CO_2 concentrations, the high caustic alkalinity developed in this decomposition makes it impossible at higher operating pressures to keep within the alkalinity-sulphate ratio recommended in the proposed boiler code as insurance against embrittlement.

The remedy lies in the substitution for CO_3 of a substance satisfactory from the viewpoint of scale prevention and entirely stable at the operating pressures. It has been one of the most pleasing developments of this investigation to establish the proof that PO_4 gives beautiful results on the side of scale prevention and that the total alkalinity necessary in the boiler water can easily be kept well within the limits recommended from the viewpoint of caustic embrittlement.

A satisfactory and economical answer to the complete conditioning of water for high-pressure operation may be given as follows:

If the makeup water is evaporated and the only impure water entering the boiler consists of the condenser leakage, then the conditioning of the boiler water with phosphate is the only chemical control necessary. If the makeup water is not evaporated and is of some magnitude, then economy demands the pretreatment—with lime and soda ash for any water or by a base exchange process if the water is not high in temporary hardness—followed by the final conditioning of the boiler water with phosphate. In the pretreatment, however, any addition whatever of excess chemical must be avoided else detrimental concentrations of caustic alkalinity will develop in the boiler water. If it is deemed desirable to limit the amount of soluble solids in the boiler water and the feed water is one that contains sulphate, a variation in pretreatment may be made by using barium carbonate in place of sodium carbonate, thus removing much of the sulphate as well as the calcium. In any event, however, the final control of the boiler water must be based on the use of a suitable substance such as phosphate.

Prevention of Scale Formation on Feed-Water Lines, Etc.

The problem of preventing scale formation on feed-water lines and preheating sections is much simpler than in the case of evaporating surfaces, since (1) there is only one main constituent in these scales, namely, calcium carbonate ($CaCO_3$), (2) deposition of insoluble solid material occurs by reason of supersaturation throughout the body of the water and not at the surfaces alone as in the case where evaporation is occurring, and (3) no decomposition of the chemical used in treatment occurs.

In order to prevent scale formation on these surfaces, it is necessary that no bicarbonate (HCO_3) remains in the water, and it is advisable that a small concentration of caustic soda (NaOH) and loose crystals of suspended calcium carbonate be present. This condition may be maintained in a water that has been correctly treated externally or by using the excess caustic alkalinity in the boiler water itself. The latter control involves recirculating water from the boiler through the feed lines or the preheating sections.

Prevention of Corrosion

On the basis of experiments that are described under the heading of corrosion prevention, it is concluded that in general any corrosion of the boiler-system surfaces in contact with water is electrochemical in character. Anodic

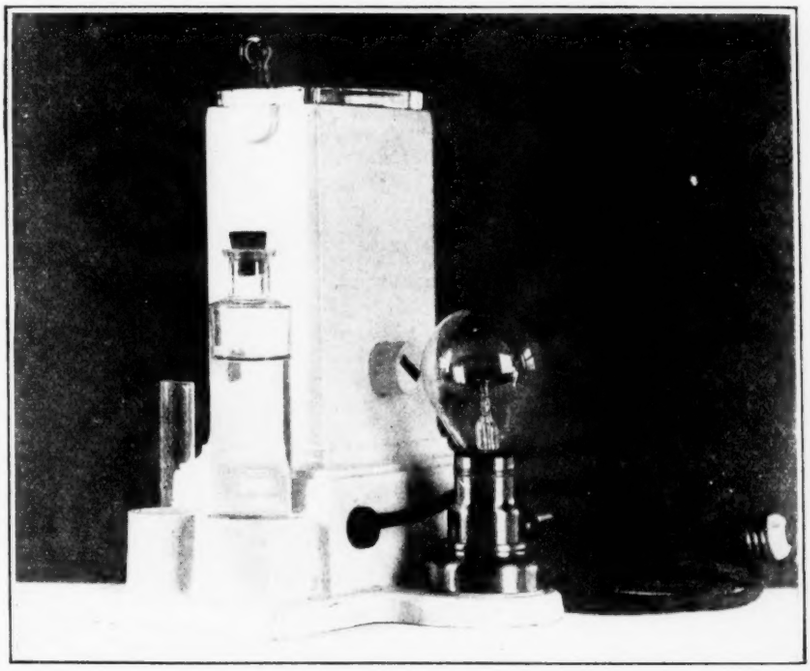


Fig. 2—Rear view of sulphate concentration gage, showing slot illuminated by electric bulb

conditions in the metal develop from differential oxygen concentration, especially in feed lines and economizer tubes, from impurities in contact with the metal (as mill scale) or from a state of strain or local differences of temperature. The control of corrosion, therefore, signifies so conditioning the water that at any anodes that may develop, passage of current generated results not in the dissolution of the boiler metal, but in the discharge at the anode of some component in the boiler water. It is our belief based on experimental work and operating control now in progress (1) that hydroxide (OH) is a specific remedy for corrosion in the case of sulphate waters, and satisfactorily inhibitive for practical purposes with chloride waters, (2) that the control for the prevention of corrosion is as exact as that given for elimination of scale formation, and (3) that even in the extreme case of a raw water saturated with air, feed line or economizer corrosion can be reduced to negligible proportions.

The control of sludges and soluble salts in the boiler water, their relation to wet steam and the removal of any boiler water and its suspended insoluble material from the steam before it leaves the boiler nozzle are as integral parts of any complete system of boiler-water conditioning as the factors that have been considered already. It was the purpose of this paper, however, to present those features of such a system in which the Bureau of Mines is actively co-operating. This has been done, and I must, therefore, extend this discussion no further.

In this research covering a period of four years, it is impossible adequately to recognize the achievements of all those associated in the development, but the author takes pleasure in ascribing any success attained to the unstinted support that has been given by A. C. Fieldner, chief chemist of the Bureau of Mines, and J. M. Hopwood, president of the Hagan Corporation as well as to their respective organizations.

Belt Traveled Nine Million Miles in Forty-Eight Years

By Louis W. Arny
Secretary The Leather Belting Exchange

THE Bernon Mills, at Georgiaville, R. I., now owned and operated by the Manville-Jenckes Co., manufacturing cotton goods, have contributed some very valuable information regarding the transmission of power by belting, through the life history of an old leather belt which they have recently discarded. This belt, 130 ft. long, 42 in. wide, three-ply, said to be the first wide three-ply belt ever made, was used as a main driver on a George H. Corliss double-horizontal-type engine, and was installed in November, 1876, and has run continuously on this drive until a few months ago, subject to the usual vicissitudes incident to such a drive. During the life of this belt there was one period of six months in 1885, when the mill was not operated (and there have been numerous periods when it made overtime), and on two different occasions it was necessary to remove the belt because of threatened high-water. In 1911, when the belt had run 35 years, it was thought desirable to remove the ply that had been next to the pulley and to add a new ply to the outside of the belt, but aside from this no repairs have been made. A few months ago a broken mainshaft on the engine necessitated the removal of the belt, which had been operating in an entirely satisfactory manner up to that time. Inasmuch as the company had idle another belt of the same general dimensions at one of its other mills, it was thought wiser to substitute the idle belt and to bring the service of this old belt to a close, though it probably would have run several years more.

This belt runs over a 30-ft. driving pulley on the engine to a 7-ft. pulley on the mainshaft. Originally, it was installed to transmit 500 hp. with the engine operating at 45 r.p.m., but after the belt had run some years there was a demand for more power, so the steam pressure was raised and the speed of the engine increased to 61 r.p.m. The larger part of the life of the belt has been under the latter conditions. The belt speed is 5,740 ft. per min., and under its normal load the driving tension is 110 lb. per inch of width.

It will be observed that the tension on this belt is higher than that usually considered desirable, and the load carried consequently is 10 per cent to 20 per cent larger than that recommended by the various authorities on belt transmission. It also will be noted that the speed is very high, 5,740 ft. per min., in consequence of which the centrifugal tension is 2,520 lb. It likewise will be seen that the center distance, relatively, is very short for a belt of this size, that there is only 13 ft. between the rims of the two pulleys; and that the pulley ratio, more particularly because of the short center distance, is unfavorable, the belt driving from a very large pulley, 30 ft., to a relatively small pulley, 7 ft.

This belt cost, in 1876, $1,317. In 1911 a new ply was added, as stated, at a cost that is not definitely known, but it can be estimated at $600, making the total cost of the belt $1,917. When the belt was discarded, it was sold for $300, so the total cost has been $1,617, or $33.73 a year, making the total cost of transmission so small as to be almost ridiculous and unbelievable.

During its lifetime this belt has traveled 9,387,200 miles. Its pulleys have been large, so that the flexure of the leather has been small. At the same time each particular fiber of this belt has flexed to conform to its pulleys some twelve million bends a year, and during its lifetime each particular part has been bent forward and back some five hundred million times. The belt originally was made of a high quality of leather, probably not any better and possibly not so good as the best belt leather available today, though much superior to the poorer qualities. During the last 42 years of its life it has had very careful treatment by W. H. McAbee, who has been steadily in charge of this power plant for that period, and to whom some considerable part of the credit for the long life of the belt, in its freedom from accidents, must be attributed.

To determine the depreciation that has occurred in the quality of the leather, some samples of the original belt have been taken at random and tested with the following results:

Minimum strength of six specimens, 1,870 lb. per sq.in.

Maximum strength of six specimens, 2,850 lb. per sq.in.

Average strength of six specimens, 2,400 lb. per sq.in.

New material of the same high quality has a breaking strength of 5,000 to 6,000 lb., so that the material in this belt has depreciated 50 per cent to 60 per cent from what probably was its original strength, but its present strength is many times the greatest tension that can be applied to it as a belt. A striking illustration of the salvage value of the leather belt is that this one, after it had run 48 years, was sold for $300. It has been cut up into smaller belts and into straps, washers, etc.

This old belt, and the engine on which it runs, have outlived everybody connected with their manufacture and installation. George H. Corliss then was at the apex of his glory as a builder of the great Centennial engine, but he and the makers of the belt and the owners of the mill, and the engineers and superintendents in the plant, all have been gathered to their fathers, and the old belt and engine have outlived them all.

There are so many conditions that enter into the operation of a belt that there is difficulty in applying to one installation any experience derived from another, and probably not many belts, under different conditions in which they run, will last so long or travel so many miles, though they may do as much useful work, but in general this story shows the wisdom and economy of buying belts made of good material and the profit in taking good care of them. It also shows that the horsepower tables for leather belts, at least as applied to belts running over large pulleys, are very conservative, and hence practical, and it confirms the experiments of The Leather Belting Exchange Foundation, which showed that the peak of load capacity for belts under this tension was at 6,000 ft. per min. It also shows that leather belts can travel at this high speed without injury or excess wear where the pulleys are of sufficient size. It emphasizes that old fact that cheap transmission is to be derived from belts with a long life. Wherever the leather belt has a chance to wear itself out in service, in distinction to being destroyed in accidents or through neglect, it provides transmission at a cost that is not approached by any other medium.

*Paper just released by the Leather Belting Exchange.

News in the Field of Power

Power Houses at Mine Mouth Advocated for Britain

The British Government has announced that its new "electricity scheme" is complete and will be introduced into Parliament early in February. The main points are that power houses are to be built at the mine pits' mouth and the power is to be delivered to cities and villages throughout Great Britain. A grant of $75,000,000 will be made by the government, according to an article written by Herbert N. Casson, from London, in the *Public Ledger* of Philadelphia.

There will be fewer and larger stations, and the equipment will be standardized.

For more than a year the government has been gathering data on the electrical situation. An able committee has been in charge of the survey. The chairman was Lord Weir, a practical Scotsman, of Glasgow.

Lord Weir is no socialist. He is not in favor of state control. So he has suggested that the new electrical developments be carried on by town councils and private companies.

He has given England a new slogan —"electricity for all." He has prepared a plan that appears to be practical and progressive. It will go through Parliament with little opposition.

This scheme will cover Great Britain, outside London. As for London, it has now a "joint electricity authority," which is unifying and extending the electrical stations of Greater London.

There are now in this area 43 electrical companies and municipal departments, with a revenue of $55,000,000. This is not large, when it is remembered that Greater London covers 1,800 square miles and has a population of 8,000,000.

The fact is that Great Britain is now thoroughly aroused on the matter of electricity. The power conference, which was held at Wembley in 1924, opened the eyes of the British people. They were amazed to find that Britain is at least twenty years behind America, Canada and Switzerland in the use of electrical power.

The latest figures show that Canada is producing 4,290,000 hp. from hydroelectric plants.

During 1925 Canada spent $70,000,000 on new developments. With one-fifth of the population of Great Britain, the Dominion has completely outstripped her in production of cheap power.

In Great Britain the total capital now invested in all branches of electrical industry is $3,500,000. The new capital brought in during 1925 was not more than $150,000,000.

There are about 200 producing companies in Great Britain, but all of them are small. All combined produce less electricity than the companies of New York City alone.

It is an extraordinary fact that there is more electricity per capita in Finland or Shanghai or any American village than there is in the industrial towns of the north of England. In Manchester there are only 30,000 users of electricity, and there are more than 2,000 factories that have no electric light.

State Control Blamed for Loss of Progress

This loss of twenty years in electrical progress is generally attributed in Britain to the dead hand of state control and to the political power of the gas companies.

Britain has no water power, but she has coal mines scattered widely about. Outside the Scotch Highlands, there is not a district in Great Britain that is more than 100 miles from a coal mine.

From the first, all British electrical companies have been regulated by the Board of Trade. They have been ruled by a board of five commissioners, all of whom are political appointees.

Strictly speaking, there are no independent private companies producing electricity. Not one company would dare to erect a new building without asking the consent of the commissioners. All the London companies are operating under franchises that will expire in 1971.

Lord Rothemere says, "The economic welfare of the United States is based more than anything upon the fact that she has 29,000,000 hp. of electrical power in her factories—equivalent to 290,000,000 human workers."

He points out that the cost of electrical power is three times as much in Britain as it is in Chicago.

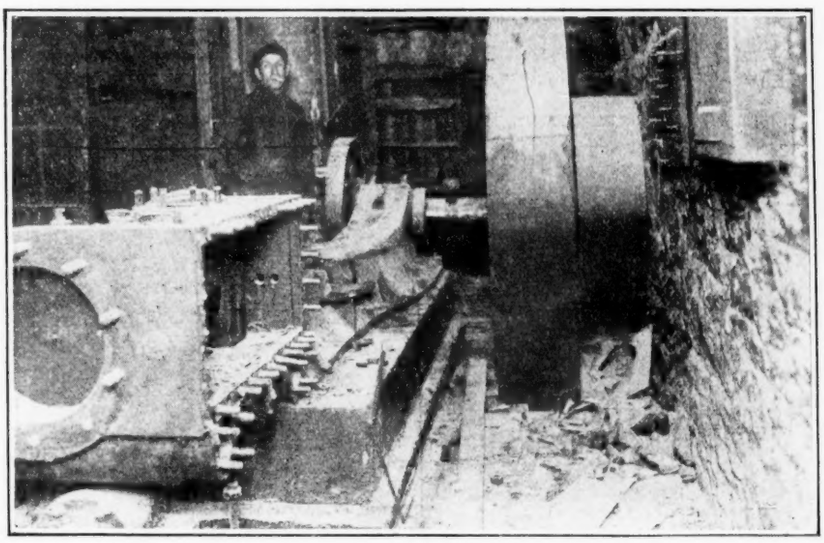
What Britain most needs at the moment is an electrical expert of the first class he said.

Part of N. Y. City Waterworks of 1799 Uncovered

Excavating for the foundation of the new Court Square building in New York City, which is being constructed for the Harper organization, a deep well was discovered on Jan. 24, which was thought to have been one of those belonging to the old water works system installed by the Manhattan Co. founded by Aaron Burr in 1799 "for supplying the City of New York with pure and wholesome water." Not only was this well discovered, but in tearing down a building, an old engine was found that was thought to be connected with the system. This proved to be the case, as Henry E. Janes, of Janes & Kirtland, who as a boy tended to seeing that a small pump connected with the engine was kept in order for the supplying of water to a tank belonging to the Manhattan Co., testifies in a letter in the *Herald-Tribune*, as follows:

> The engine shown in your photograph was not the pumping engine; this is a large Corliss engine, which was used by my firm to supply power for ourselves and our tenants on Reade Street. The original pumping engine for the water company was taken out and was not in place many years before this, but a small pump for keeping the water supply in the tank was in place, and this was run by our large engine, the flywheel of which is shown in your photograph.
>
> It was part of my duty as a boy more than fifty years ago to see that our engineer did not neglect the care or the orders to keep the supply of water for the Manhattan Company in good shape. In those days it was a very wonderful spring; the water was as clear as crystal, and I had many a cool drink from it over fifty years ago. Pipes led from it out to the different parts of the city, made of wood, logs hollowed out and dovetailed into one another.

A sign designates this "Russell engine." (Made by predecessor of Griscom-Russell Co.)



Old Russell Corliss engine which helped the Manhattan Co. founded by Aaron Burr to keep its charter of 1799

Work's Boulder Dam Plan Favored by Senator Johnson and Representative Swing

Taking Colorado River out from Under Water Power Act Meets Snag—Arizona Serves Notice That She Can Hold Development Up Through Litigation

SENATOR JOHNSON and Representative Swing, of California, have accepted the plan of Secretary Work for the construction of the Boulder Dam project and for the building of the all-American canal. Arizona, however, has raised a strenuous protest against the "coercing of a sovereign state by the federal government." Senator Ashurst, Arizona's senior Senator, has raised the point before the Irrigation Committee that the proposal to raise money by the sale of power makes the bill a revenue measure which, under the rules, must originate in the House. Some of the committee members are inclined to agree with that point of view. Senator McNary, the chairman of the committee, is not particularly friendly to the Work proposal.

As a result of the differences that have arisen, it may be that the Senate committee, which has held its hearings and was ready to act on the original Swing-Johnson bill, will be slow in bringing the matter to a final vote.

Arizona Will Fight Legislation

On the House side Representative Hayden, of Arizona, has served notice that Congress will involve the Colorado River in litigation that will last for a generation if it passes the proposed legislation. He says that his state will enjoin any works started on the Colorado under any such plan. Apparently, the House committee recognizes that Arizona is in a position to delay the project greatly.

There also is objection to the bill from those who are not concerned particularly with what may happen to Arizona. There are many who think the development of the Colorado should be undertaken by private capital. They think the water power act should be let alone. Congress, after ten years of effort, sets up a water power policy, they point out. The ink hardly is dry on the statute books until various efforts are set on foot looking to a different policy on the more important power streams. If these efforts are successful, it is contended, capital which has begun to flow into water power developments, will be withdrawn from such undertakings. There is nothing to justify the investment of the tax payers' money in a business undertaking of this kind into which private capital is ready to go.

The point also is made that since Arizona pays a portion of the taxes which would be used in the construction of the proposed government project, it could not be denied the benefits of the development.

Pittman Bill Thought Hastily Considered

The Pittman bill, which would suspend the authority of the Federal Power Commission to confer rights on the Colorado River or its tributaries, apparently has no chance of being considered by the House Committee. Some of the Senators who allowed the measure to get through the upper House now regret that they did not insist upon the consideration of the bill by committee.

The bill was rushed through the Senate before an opportunity had been offered the Cabinet members concerned to report on the measure. Consideration was not given to the fact that the suspension of the Power Commission's authority would bring to a standstill most electrical development in the entire Colorado basin. No transmission line over public lands could be authorized. No extensions of existing hydroelectric plants could be undertaken.

The Pittman bill had as its object the blocking of the possibility of any extension of rights to private interests on the river. The Commission, in withholding action on the Girand application for license, made it clear that a reasonable time only would be allowed for the states to reach an agreement among themselves as to a Colorado River policy. Some fear is entertained by the states that the Commission might go ahead and issue the Girand license for the development at Diamond Creek.

Report of N. Y. State Water Power Commission Opposed

The report of the New York State Water Power Commission was filed with the Legislature at Albany on Jan. 25. It has caused considerable discussion in the legislative halls.

In a statement summarizing its report, according to the press, the Water Power Commission said:

> A projected hydro-electric development of 2,000,000 hp., largely on the Niagara and St. Lawrence Rivers and the State Barge Canal, the consummation of which will place New York State in the forefront as a producer of electric energy, is embraced in the program of the State Water Power Commission, evidenced by the report filed with the Legislature today.
>
> The successful completion of this ambitious plan is made possible by the pioneer work of the commission during 1925 in adopting a definite state water power policy.
>
> The present electrical requirements of the state call for the production of 5,000,000 hp. a year, of which nearly 2,000,000 hp. is now produced by water power. With the demand for current increasing at an astounding rate, the commission felt that it was high time to end the discussion of water power theories that has marked the last twenty years and substitute a plan of action that will promptly give the people of the state the benefits resulting from the full development of cheaper hydro-electric power.

The commission is composed of Alexander MacDonald, Conservation Commissioner; Roy G. Finch, State Engineer and Surveyor; Albert Ottinger, Attorney General; John Knight, temporary president of the Senate, and Joseph A. McGinnies, Speaker of the Assembly.

Governor Smith, in speaking about the report, said:

> I am unalterably opposed to giving permits to these big corporations for the development of water power, which should be developed under state control. A special message to the Legislature on the topic, urging it to take such action as may be necessary to change this policy and, if necessary, repeal the water-power law before these rights are disposed of to private corporations, is in process of preparation.

The Governor announced that a special message to the Legislature expressing opposition to the suggestions of the Water Power Commission for the leasing of power concessions in waterways controlled by the state was being prepared, and he intimated that he might go so far as to ask for the abolition of the power commission.

National Marine Engineers' Beneficial Association Convention

Crude Oil Production Still Decreases

The American Petroleum Institute estimates that the daily average gross crude oil production in the United States for the week ended Jan. 23 was 1,928,350 bbl., as compared with 1,947,600 bbl. for the preceding week, a decrease of 19,250 bbl. The daily average production east of California was 1,315,350 bbl., as compared with 1,328,100 bbl., a decrease of 12,750 bbl.

Additional Diversion at Niagara Permit Extended

The temporary license of the Niagara Falls Power Co. covering an additional diversion of 225 sec.-ft. has been extended for ninety days from Jan. 25. This is a part of the 500 sec.-ft. previously withheld to cover minor diversions. Of that amount 275 sec.-ft. is being used by the mills on Eighteen Mile Creek. Negotiations with the power users on Eighteen Mile Creek are said to be progressing satisfactorily, and a license probably will be issued in the near future covering that diversion.

Three St. Lawrence Rapids Foundation Conditions Good

The fact that good foundation conditions have been found to exist at the principal three rapids on the St. Lawrence is a fortunate circumstance which has an important bearing on the cost of the project, it was emphasized at the January meeting of the Joint Engineering Board, when the practically complete record of the borings was available.

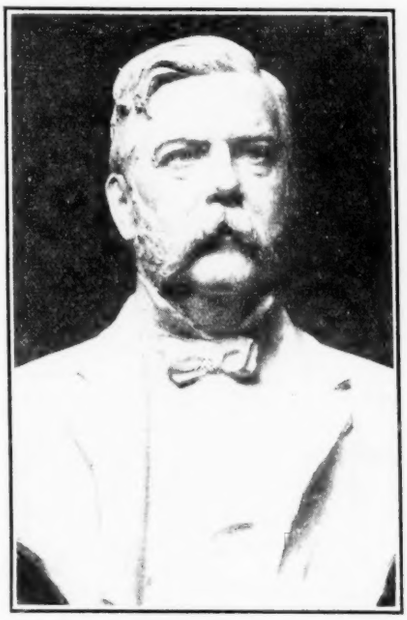
The co-operation, pledged so wholeheartedly by the Ontario Hydro-Electric Commission at the last meeting of the Board, has great significance, it is pointed out. Officers of the Commission expressed their views frankly and gave the engineers the advantage of their opinions on many important points. Valuable engineering data have been made available to the Board. The Frontier Power Co. also has contributed importantly to the work of the Board by turning over the records of its borings.

Another meeting of the Joint Board will be held in February and everything is being done to expedite the report.

Bust of George Westinghouse On Exhibition

The recently completed bust of George Westinghouse, by Daniel Chester French, has been on exhibition at the Union League Club Galleries, Fifth Ave. and 40th St., New York City, for some days.

The bust was commissioned by a committee of engineers consisting of Ambrose Swasey, W. F. Goss, L. B. Stillwell, E. M. Herr, and Calvin W. Rice, Sec. of the A. S. M. E.



George Westinghouse

The portrait in bronze has been receiving favorable comments in the press and by the members of the engineering profession and is a worthy production of a great master of sculpture. It is ultimately to be a part of the artistic and biographical records of the American Society of Mechanical Engineers, where it will be placed on exhibition along with portraits and busts of the eminent members of this well-known society, which has its headquarters at 29 West 39th St., New York City.

Bankers Fight Pinchot's Giant Power Bills

Investment bankers of Philadelphia and vicinity registered opposition to Governor Pinchot's Giant Power bills, now before the State Legislature, at a meeting held by the Eastern Pennsylvania group of the Investment Bankers' Association of America on Jan. 22.

A resolution urging the Legislature to defeat the measures was adopted by the bankers following addresses in which the Governor's program for the creation of a governing board with wide regulative and directive powers was declared unsound, unwise and radical legislation.

The resolution was as follows:

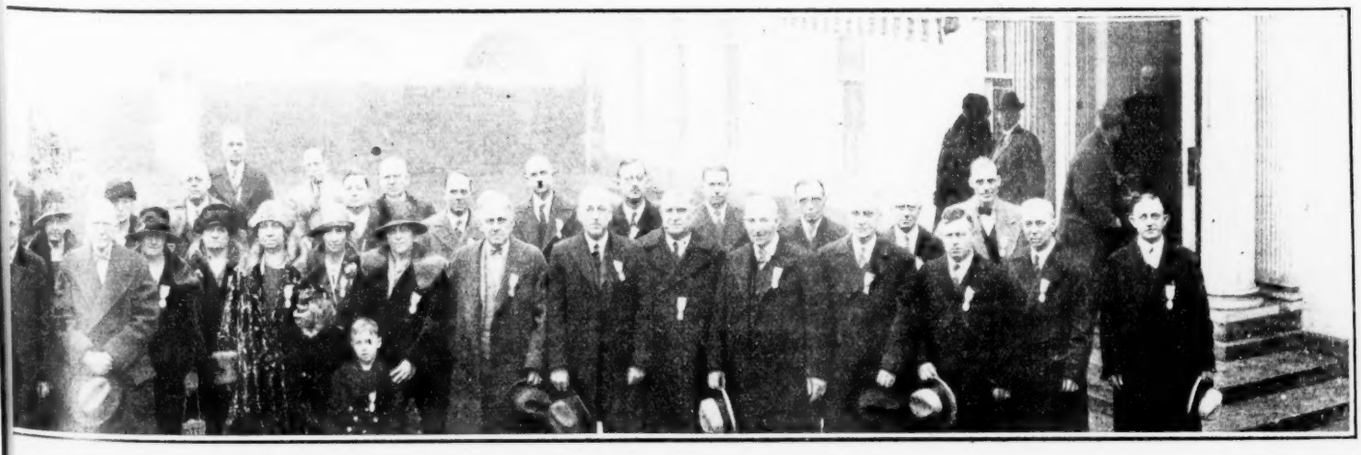
Resolved, That the so-called Giant Power bills now pending in the Legislature of Pennsylvania are unsound in principle and should be defeated because they are contrary to the best interests of the citizens of the Commonwealth of Pennsylvania, the development and growth of its necessary public utilities and to the investors in the securities thereof.

Holzwarth Gas Turbine Co. of America Formed

The Holzwarth Gas Turbine Co. of America, recently incorporated in Delaware, has acquired the patents and rights to manufacture and sell in the United States and Canada the Holzwarth gas and oil turbines which have been developed and built by Thyssen & Co., Mulheim-Ruhr., Germany, according to a statement issued by *Marine Engineering and Shipping Age*.

Hans Holzwarth, inventor of the turbine and former chief engineer of the Thyssen Works, is vice-president and engineering director of the American company. The offices of the company are located at 504 Standard Oil Bldg., San Francisco, Calif., and its European address is care of Thyssen & Co., Mulheim-Ruhr, Germany.

The American company has negotiated certain contracts with the Thyssen firm in Germany, and prolonged tests under commercial conditions are to be run on a 5,000-kw. gas turbine and a small oil turbine at the Thyssen Works in the near future. Invitations to witness these tests have been extended by the American company to a number of engineers, manufacturers and power-producers in the United States and in other countries.



after the reception at the White House by President Coolidge

Alexander Falls, Ont., Plant To Increase Capacity

The Ontario government has granted the Hydro-Electric Power Commission of Ontario authority to proceed with the development of the Alexander Falls power project on the Nipigon River. The development will require an outlay of approximately $7,000,000, bringing the government's investment in the Thunder Bay district to more than $18,000,000.

It will produce an additional 50,000 hp. to supplement the 65,000 hp. already developed there. Delivery of the additional power is expected to begin in 1928.

Conowingo on Susquehanna Financing in Progress

The Susquehanna Power Co. asked permission of the Maryland Public Service Commission on Jan. 25, to issue $38,000,000 worth of bonds as the first step in carrying out the Conowingo superpower project.

The petition says that no definite commitment for the sale of the bonds has been entered into. Work is expected to start early in the spring.

News comes from Washington, that the early issuance of the license covering the development at Conowingo is in prospect. The revised plans are being studied as are the proposed security issues.

A public hearing on the financial phases is being held by the Federal Power Commission this week.

Missouri Pushing Plans for Power Development

The engineers of the Federal Power Commission have concluded their studies of the Current River, in Missouri, and will recommend the issuance of a preliminary permit to the Missouri Hydro-Electric Power Co. They feel that the plan of this company has certain advantages over those of John A. Shafer and the Central Missouri Power & Water Co., conflicting applicants.

The Missouri Hydro-Electric Power Co. proposes to develop 60,000 hp. at three power houses. A condition of any license that may be issued on this stream will be that nothing be done to mar the natural beauty of the state park at Big Springs.

In order to expedite the development of the Current River and other Missouri streams, the state authorities have cooperated actively in furnishing engineering data. The state highway department has altered its road program so that the highway will use the dams for crossings, thereby making the development much less expensive.

Plans for the development of other Missouri streams are well advanced. An application by Walter Cravens, on the Osage River, has been found satisfactory. This involves the erection of a dam 100 ft. high and the creation of a pool extending from Bagnell 100 miles to Warsaw.

There also is activity on the upper White River and on the Gasconade River indicating that Missouri soon is to have several hydro-electric developments.

Pennsylvania's New Boiler Code Available

According to the Department of Labor and Industry, Commonwealth of Pennsylvania, the revised Boiler Regulations are available for distribution. Copies may be obtained by addressing Cyril Ainsworth, Secretary of the Industrial Board, Harrisburg, Pennsylvania.

The effective date has been changed from Oct. 1, 1925, to November 15, 1925.

The revised regulations represent the experience gained since 1916 in administering the first Code. They are practically identical with the revised A.S.M.E. Code, with the addition of sections on Administration, Definitions, General Specifications, and Miniature Boilers.

The Boiler Code is divided into three parts: Administration, Definitions, and Specifications. Part 1 on Administration is subdivided into two Sections: General Requirements, and Information for Those Desiring Commissions as Boiler Inspectors. Part 2 is in one section, and contains the definitions, while Part 3 is subdivided into the following sections: General, Power Boilers, Miniature Boilers, Locomotive Boilers, Material Specifications, Heating Boilers, and Inspection.

Obituary

Willard H. Platt, a prominent resident of Brooklyn, passed away in his seventy-second year at his home, 115 Cambridge Place, Jan. 21. Mr. Platt was born in Niagara-on-the-Lake, Canada, in 1854 and went to New York when he was about twenty. In 1856 he became connected with Greene, Tweed & Co., finally becoming president and treasurer, which offices he held at the time of his death. He was a trustee and a treasurer of the Emmanuel Baptist Church; treasurer and financial manager of the Leland University of New Orleans and put the institution on a sound financial basis; and for many years a member of social and business clubs and associations of Brooklyn and New York. He was interested in the World War activities, giving many instruments to the Fourteenth Regiment Band and presenting a motor lorry. Surviving him are his wife, two sons, (Willard R. Platt of 115 Cambridge Place and Harold B. Platt of Upper Montclair), a daughter and two grandchildren.

Gordon Oke Philp, the young general superintendent of all operations and maintenance of the Ontario Hydro-Electric Commission, died after a month's illness on Dec. 24 of blood infection. He was born in Port Hope and received his high school education there. Later, he entered the University of Toronto, graduating as a Bachelor of Applied Science in 1914. During his vacations he received practical experience with the Midland Construction Co. in Central Ontario. After graduation he entered the engineering department of the Electric Power Co., and when this company was taken over by the Ontario government in 1916, he joined the staff of the operating department of the Commission. Upon the acquiring of the Ontario Power Co. by the Hydro Electric Power Commission, he was chosen as the man having the most suitable qualifications, both personal and technical, to act as general superintendent. During the last few years added responsibility was placed upon him, and at the time of his death he satisfactorily held the position of general superintendent of all operation and maintenance of the Commission's three properties: Queenston-Chippawa Development, Ontario Power Co. and the Toronto Power Co., as well as the operation and maintenance of the substations and transmission lines of the commission in the Niagara district.

S. Boswell died on the 26th of December, 1925, at his residence in Manchester, Eng. Mr. Boswell had reached the age of seventy-six, and had been active until quite recently. He was for some years very prominent in connection with the affairs of the Manchester Association of Engineers, of which society he was ex-president and a member of council. For a period of about forty years Mr. Boswell was on the staff of Galloways, Ltd., and prior to that he was employed as an inspector by the Manchester Steam Users' Association.

Personal Mention

Stanley Stokes has been appointed assistant to the vice-president of the Union Electric Light & Power Co., St. Louis, Mo., and will be entrusted with the duties of power supervisor.

George Bain, chief engineer of the "Scythia," belonging to the Cunard Line, will celebrate the completion of forty years of service with this steamship company, during the present Mediterranean cruise of the steamer.

F. H. Moorehead, chief engineer of the Walworth Company, Boston, Mass., has taken over the duties recently relinquished by John C. Bannister, who was vice-president in charge of engineering, before his retirement on Jan. 1.

William S. Schmidt, who has been connected with the Penn Public Service Corporation in Johnstown for a period of four and a half years, has severed his connection with that organization to join the Pennsylvania-Ohio Power & Light Co., with headquarters at Youngstown, Ohio. Mr. Schmidt will serve in the capacity of special engineer directly under George A. Iler, chief electrical engineer.

Society Affairs

The Providence Engineering Society, 44 Washington St., Providence, R. I., will hold its annual meeting and banquet at the Providence Biltmore Hotel, Feb. 10. The theme of the evening will be "Guiding Civilization," with Dr. E. J. Cattell, Col. H. B. Ferguson and Clarence T. Hubbard as speakers.

The American Ceramic Society will have two papers of interest to *Power* readers at its coming convention, which is to be held at Atlanta, Georgia, Feb. 8-11: "Variable Load Tests on

Fifty Brands of Refractories," by M. C. Booze, Refractories Institute, Pittsburgh; "Specifications for Buying Refractories," by J. Spotts McDowell. Pittsburgh, Pa.; "Service Requirements of Plastic Refractories," by Hugh Weightman, Ferguson, Mo.

The Engineering Society of Buffalo will hold its Feb. 2 meeting at the Hotel Statler. The subject will be "Necessity for Protecting High-Pressure Steam and Water Distribution Lines, in Case of Failure, and Devices Used for Such Protection," by Payne Dean, of New York City.

Business Notes

The Diamond Power Specialty Corp., Detroit, Mich., announces the appointment of M. J. Miller as sales engineer in charge of the Detroit district.

Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill., announces that A. H. Tischer has recently joined the engineering force of the company as designing engineer.

The Pittsburgh Piping & Equipment Co., 35th & Charlotte Sts., Pittsburgh, Pa., announces that G. Howard Boddy has been appointed district representative with offices in the General Motors Bldg., Detroit, Mich.

The Strom division of the Marlin-Rockwell Corp., successor to the Strom Ball Bearing Mfg. Co., 4527 Palmer St., Chicago, has moved its Philadelphia office to 1211 Franklin Trust Bldg., 15th & Chestnut Sts. A. W. Wiese will continue as manager in that territory.

The Foxboro Co., Inc., Foxboro, Mass., maker of indicating, recording and controlling instruments, announces that the Pittsburgh, Pa., office of the company has been moved from the Park Bldg. to the Foxboro Bldg., cor. of Sixth Ave. and Grant St. H. S. Gray continues in charge of this office, where a substantial stock of instruments will be carried.

Trade Catalogs

Unit Heater—Modine Manufacturing Co., Racine, Wis. Bulletin "A" covers the Modine unit heater for steam or hot-water heating systems. The bulletin is well illustrated with pictures showing the adaptability to any type of building.

Turbine-Generators — General Electric Co., Schenectady, N. Y. Bulletin GEA-54 "Curtis Steam Turbine Generators" supersedes Bulletin 42206. It pictures this machine of various capacities and gives numerous photos of plants in which the equipment is installed.

Burners, Entrained Combustion Gas —Lee V. Mettler Co., 406 South Main St., Los Angeles, Calif. This catalog is in an interesting form as it is printed on both sides of heavy pressboard such as is used for the standard letter file guide. Drawings, tables of dimensions and description, are all given. Mr. Mettler has patented this idea of catalog, which is worthy of serious attention, as space for filing trade literature is a serious problem and the retention of a catalog in an office is often prevented by its size or awkwardness. This is a solution, and Mr. Mettler will grant license and permit to use to manufacturers for their own products for $25.

Blowers & Exhausters—The American Blower Co., Detroit, Mich. Bulletin No. 1608, "ABC" Pressure Blowers and Exhausters, Type P, contains, beside descriptive matter, pictures of the equipment, tables of dimensions, etc., and gives applications of this special type blower.

Electric Equipment — The General Electric Co., Schenectady, N. Y. Catalog 6001-B is the general catalog issued by the company which covers everything, including power plant and transmission equipment, manufactured by them. It is a bound book containing 1,106 pages, is well illustrated and arranged for quick reference.

Coming Conventions

American Boiler Manufacturers Association. D. W. Glanzer, 840 Rockefeller Bldg., Cleveland, Ohio. Meeting at Mid-Day Club, Cleveland, Ohio, Feb. 12. Annual convention at Homestead, Hot Springs, Va., May 31-June 2.

American Chemical Society. Charles L. Parsons, Mills Bldg., Washington, D. C. Convention at Tulsa, Okla. April 3-6.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Oil Burners Association. Leod D. Becker, 350 Madison Ave., New York City. Annual convention and exposition at Book Cadillac Hotel, Detroit, Mich., April 6-8.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

American Water Works Association. W. M. Niesley, Assistant to Sec., 170 Broadway, New York City. Annual convention at Hotel Statler, Buffalo, N. Y., June 7-12.

American Welding Society. M. M. Kelly, 29 West 39th St., New York City. Annual convention at 29 West 39th St., New York City, April 21-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Exposition and convention at Hotel Sherman, Chicago, Ill., June 7-10.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at The Homestead, Hot Springs, Va., May 24-27.

Heating & Ventilating Exposition. E. P. Frenz, Hotel McAlpin, New York City. Exposition at new Madison Square Garden, New York City, Mar. 17-23.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, Sept. 6-11. Annual conventions and exhibitions of state association are scheduled as follows: **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

National District Heating Association. D. L. Gaskill, Greenville, Ohio. Convention at Niagara Hotel, Niagara Falls, June 1-4.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

Power Show. International Textile Exposition—James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show will be Department "D" of the International Textile Exposition, and will be under the auspices of the New England Association of Commercial Engineers, and held at the Mechanics Bldg., Boston, Mass., April 12-17.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from June 1 to Dec. 1.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; **mine run** except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Jan. 18 1926
Pool 1	New York	$2.85@$3.25
Smokeless	Boston	2.10
Clearfield	Boston	1.85@2.25
Somerset	Boston	1.95@2.40
Kanawha	Columbus	1.55@1.85
Hocking	Columbus	1.65@1.85
Pittsburgh	Pittsburgh	2.00@2.10
Pittsburgh gas slack	Pittsburgh	1.40@1.50
Franklin, Ill.	Chicago	2.35@2.65
Central, Ill.	Chicago	2.25@2.35
Ind. 4th Vein	Chicago	2.25@2.35
West Ky.	Louisville	1.25@1.50
S. E. Ky.	Louisville	1.40@1.75
Big Seam	Birmingham	2.00@2.25
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.50@$2.75
Buckwheat No. 1.	Philadelphia	2.50@3.00
Birdseye	New York	...

FUEL OIL

New York—Jan. 28, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal.; 36@40 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Jan. 25, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5.53c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Jan. 20, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6½c. per gal.

Dallas—Jan. 16, f.o.b. local refinery; 26@30 deg., $1.65 per bbl.

Philadelphia—Jan. 27, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.68@$1.74 per bbl.

Boston—Jan. 16, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4.5c. per gal. light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati — Jan. 26, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Jan. 19, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.40@$1.45.

New Plant Construction

Ark., Lexa—Lexa Ice Co., awarded contract for the construction of a 50 ton ice and cold storage plant, two units, to W. F. Moody & Co., 613 A. O. U. W. Bldg., Little Rock. Estimated cost $125,000. Baker refrigeration equipment, two 120 hp. Diesel type K. D. Anderson engines and Allis Chalmers generators will be installed.

Ark., Searcy—Arkansas Central Power Co., Little Rock, is having plans prepared for converting electric light plant from d.c. to a.c., also the construction of a new power plant and distribution system, including transformers, etc. here. Estimated cost $35,000. Work will be done by day labor. Dickinson & Watkins, Little Rock, are engineers.

Calif., Fresno—Southern Pacific Co., 65 Market St., San Francisco, plans the construction of a round house, ice plant, etc. here. Estimated cost $1,500,000. G. W. Boschke, is chief engineer.

Calif., La Mesa—La Mesa Lemon Grove & Spring Valley Irrigation District, is having plans prepared for the construction of several auxiliary pumping plants and reservoirs, distributing mains, etc. T. H. King, 920 8th St., San Diego, is engineer.

Calif., Long Beach—City had plans prepared for the construction of a new sewage pumping plant in Alamitos Bay District. Estimated cost $25,000. R. D. Van Alstine, is city engineer.

Calif., Ramona—Ramona Irrigation District, is having plans prepared for the construction of pumping plants, reservoirs, etc., in connection with irrigation works. Estimated cost $85,000. T. H. King, 920 8th St., San Diego, is engineer.

Fla., Miami—Beverly Arms is having plans prepared for the construction of a 15 story apartment on N. E. 34th St. Estimated cost $3,000,000. Stuckert & Co., 1420 Chestnut St., Philadelphia, Pa., are architects and engineers.

Fla., Miami—City plans an election Feb. 10 to vote $600,000 bonds for extending the water system, including filter plant, installation of pumps, etc., also $375,000 for purchasing and installing pumps and equipment for high pressure water system.

Fla., Miami — The Shoreland Co., c/o Miami Shores Co., awarded contract for the construction of a 10 story hotel at Federal Highway and 122nd St. to Markley Construction Co. Estimated cost $1,250,000.

Ill., Chicago — Hooper & Janusch, 879 North State St., Archts., will receive bids about Feb. 15 for the construction of a 16 story apartment including oil burning system and 2 elevators at Cass and Delaware Sts. for C. W. Morris, 111 West Washington St. Estimated cost $1,750,000.

Ia., Sioux City—Swift & Co., Stock Yards, awarded contract for the construction of a creamery and cold storage plant at Chambers and Dave Sts. to W. A. Klinger, Warnock Bldg. $100,000.

Kan., Topeka—Seymour Packing Co., 200 North Kansas St., awarded contract for the construction of a 5 story cold storage plant to F. M. Spencer & Son, 1805 Harrison St.

La., Alexandria—Commonwealth Utilities Corp., W. F. Carl, Pres., awarded contract for the construction of an ice plant to J. W. Quick, Lake Charles. Estimated cost $100,000.

Mass., Boston—Boston & Maine R.R., North Station, is having plans prepared for the construction of a coaling plant, including five loading towers and distributing bridge at Mystic Wharf. Estimated cost $500,000. F. A. Merrill, is chief engineer. Conveying equipment, loading buckets, etc., will be required.

Mich., Detroit—J. B. Book, Jr., Book Bldg., Washington Blvd., plans the construction of a 22 story office building including steam heating equipment at Washington Blvd. and Grand River Ave. Estimated cost $2,000,000. L. Kamper, 3729 Cass Ave., is architect.

Mich., Detroit—C. H. Miles, Miles Theatre Bldg., State and Griswold Sts., is receiving bids for the construction of a 16 story theatre and office building including steam heating equipment on Adams Ave. P. R. Pereira, 333 State St., is architect.

Mich., Detroit—Public Light Commission, J. S. Foley, Secy., 174 East Atwater St., is readvertising for bids for boiler settings and ash handling equipment for municipal power and light plant on Morrell St. Former bids rejected.

Mich., Detroit—Village of Clinton, R. F. Marshall, Clk., will receive bids until Feb. 5 for the construction of a waterworks system, including a 350 g.p.m. triplex motor driven pump, 350 g.p.m. horizontal centrifugal motor driven pump, well, 100,000 gal. water tank, etc. Van Tuyl Heartt & Barron, 1112 Union Trust Bldg., are engineers.

Mich., Detroit—F. Wardell, Dewey and Hamilton Aves., awarded contract for the construction of a 12 story hotel including steam heating equipment on Woodward Ave. to Bryant & Detwiler, 2336 Dime Bank Bldg. Estimated cost $2,500,000.

Miss., Gulfport—City plans extensions to artesian reservoir, also plans the installation of a heavy-duty service pump for fire mains. Estimated cost $50,000. G. W. Odom, City Hall, is engineer.

Mo., Ilmo—General Box Co. is in the market for a 150 lb. pressure feed water heater, 500 hp. boiler, one 3 ph., 60 cycle, 200 v. 100 kva. synchronous motor and General Electric or Westinghouse automatic voltage regulator for two exciters.

Mo., Republic—City Clerk, is receiving bids for improvements to waterworks including pumping equipment, tank on tower, mains, etc. Estimated cost $65,000. Gantt-Baker Co., Inc., 1116 West Main St., Oklahoma City, Okla., is engineer.

Mo., St. Louis—City, E. E. Wall, City Hall., Dir., will soon receive bids for four 650 hp. boilers with auxiliary appurtenances, including coal and ash handling machinery, etc., two 30,000,000 gal. turbine driven centrifugal pumps, two 40,000,000 and one 60,000,000 gal. steam turbine driven centrifugal pumps, etc. Estimated cost $525,000, $412,500 and $237,500 respectively.

Mo., St. Louis—Knights of Pythias, c/o St. Louis Lodge Deputies Assn., will soon receive bids for the construction of a 19 story office and theatre building at Grand and Delmar Blvds. Estimated cost $1,000,000. W. T. Trueblood, Chemical Bldg., is architect.

Mo., St. Louis—T. G. Watts, et al, 621 Chestnut St., is having preliminary plans prepared for the construction of a 20 story apartment at Lindell Blvd. Estimated cost $1,000,000.

Neb., Ohlowa—Village, J. P. Moor, Clk., will receive bids until Feb. 15 for the construction of a waterworks system, including a 35,000 gal. tank on 100 ft. tower, one 45 g.p.m. single stroke deep well pump, 30 crank r.p.m., one 75 g.p.m. two stroke deep well pump, 30 crank r.p.m., one 7½-hp., 3 ph. 200 v. 1200 r.p.m., a.c. motor, one 10 hp., 3 ph. 200 v., 1200 r.p.m., a.c. motor, etc. Henningson Engineering Co., National Bldg., Omaha, is engineer.

N. Y., Albany—City Ice & Fuel Co., H. O. Norval, Pres., 6610 Euclid Ave., Cleveland, O., is having plans prepared for the construction of a 160 ton artificial ice plant here. C. C. Coneby, c/o owner, is architect and engineer.

N. Y., Brooklyn—Bush Terminal Co., foot of 40th St., is having plans prepared for the construction of 2 office and loft buildings at 1st Ave. and 39th St. Estimated cost $2,000,000. W. Higginson, 15 Park Row, New York, is architect and engineer.

O., Cincinnati—Union Central Life Insurance Co., Fourth and Vine Sts., plans the construction of an 8 story office building at Third and Vine Sts. Estimated cost $2,250,000. Garber & Woodward, Union Central Bldg., are architects.

O., Cleveland—City, H. Wright, Dir. of Public Utilities, will receive bids until Feb. 5 for the superstructure of a pumping station. Estimated cost $500,000. H. Kregelius, 604 City Hall, is architect.

O., Cleveland—Cleveland Sanitary Wet Wash Co., H. H. Hood, Pres., 6204 Central Ave., is receiving bids for the construction of addition to laundry on Beckman Ave. Estimated cost $50,000. H. M. Morse Co., 720 Prospect Ave., is architect 200 hp. boiler, 60 hp. engine and a water heater will be purchased.

Okla., Carter—City, G. C. Mitchell, Clk., is in the market for a 100 hp. Diesel oil engine and cooling system for electric light plant.

Okla., Kingfisher—City wants prices and data on two 300 hp. boilers, one 750 kw. steam turbine generator for power plant. Black & Veatch, 701 Mutual Bldg., Kansas City, Mo., are engineers.

Okla., Stillwater—City had preliminary plans prepared for the construction of a sewage disposal plant including motor driven pumps, filters, etc. Estimated cost $30,000. J. W. McLendon, is engineer.

Pa., Bryn Mawr—Bryn Mawr Hospital, plans the construction of a hospital. Estimated cost $1,000,000. Zantzinger Borie & Medary, Otis Bldg., Philadelphia, are architects.

Pa., Elkins Park—H. H. Kline, Bulletin Bldg., Philadelphia, Archt., is receiving sub-bids for the construction of a 4 story apartment at York and Ashbourne Roads, here, for Pearl Improvement Corp., H. Pearl, Pres., 626 South 63rd St., Philadelphia. Estimated cost $1,000,000.

Pa., Philadelphia — Fidelity Investment Co., 325 Chestnut St., plans the construction of a 20 story bank and office building at Broad St between Sansom and Walnut Sts. Simon & Simon, 249 South Juniper St., are architects.

Pa., Philadelphia—Franklin Sugar Refining Co., Reed St., awarded contract for the construction of a boiler house and stack at Meadow and Reed Sts., to Rust Engineering Co., 311 Ross St., Pittsburgh. Estimated cost $19,435.

S. D., Hot Springs—U. S. Veterans Bureau, Room 791, Arlington Bldg., Washington, D. C., will receive bids until Feb. 16 for furnishing and installing a refrigeration and ice making plant in U. S. Veterans Hospital, here.

Tex., Cleburne—F. Merritt, Ch. Engr. and W. J. Smith, Archt., Union Depot Bldg., Galveston, will soon receive bids for the construction of a group of shop buildings, including boiler house, etc., here for Gulf, Colorado & Santa Fe Ry. Co., Railway Exchange Bldg., Chicago, Ill. Estimated cost $300,000.

Tex., Palestine—Palestine Ice Co., c/o W. B. McNaughton, plans the construction of a 70-ton ice plant. Estimated cost $140,000. Work will be done by separate contracts under the supervision of the General Engineering & Management Corp., 165 Broadway, New York, N. Y., Engrs., they will also purchase equipment.

Wis., Weyauwego—Waupaca County, L. Shoemaker, Clk., is having plans prepared for the construction of a central heating plant at insane asylum. Estimated cost $45,000. R. Cramer, 448 27th St., Milwaukee, is engineer. Boilers, etc., will be required.

Ontario—Hydro Electric Power Commission, 190 University Ave., Toronto, has been authorized by the Ontario Government to construct a 50,000 hp. hydro electric plant, including power house, dams, turbines, generators, transformers, switches, switchboard, lightning arresters, etc., on the Nipigon River at Alexander Falls. Estimated cost $7,000,000. F. A. Gaby, 190 University Ave., is engineer.

Ont., Hamilton—F. F. Trealeven, Mayor, will receive bids until Feb. 4 (extended date) for the installation of high tension equipment, transformers, five vertical motors, automatic switching equipment, etc., in Gage Avenue sewage pumping station. W. L. McFaul, City Hall, is engineer.

Ont., London—London Life Insurance Co., 424 Wellington St., will receive bids about Feb. 1 for the construction of a 4 story office building, including hot water heating system with special boilers. Estimated cost $1,000,000. J. M. Moore, 489 Richmond St., is architect.

Quebec—The International Paper Co., 100 East 42nd St., New York, N. Y., plans the construction of a water power development, 150,000 hp. capacity at Farmers here.